Mines and Minerals Branch Report of Activities 1983

Nova Scotia

Department of
Mines and Energy

Nova Scotia
Department of
Mines and Energy

REPORT 84-1

MINES AND MINERALS BRANCH REPORT OF ACTIVITIES

1983

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1984

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FOREWORD

It is with great pleasure that I commend to your attention the Report of Activities of the Mines and Minerals Branch for 1983.

I trust that you will agree with me that the scope and content of the technical summaries and reports included in this year's publication successfully document the mandate of this Branch to assist in the promotion and increased utilization of this Province's diversified mineral resource base.

I am also pleased to note that the maintenance of the Department of Mines and Energy onshore research programs during this period of retrenchment within the mining industry has been complemented by a significant increase in private sector mineral exploration and development activity in 1983.

I hope that this publication will prove useful to a wide readership in stimulating additional interest in the geology and mineral resources of Nova Scotia.

Joel R. Matheson

Joel R. Matheson, Q.C.
Minister of Mines and Energy

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SEDIMENTOLOGY STUDIES WITHIN THE SPRINGHILL COALFIELD, CUMBERLAND COUNTY, NOVA SCOTIA

J. H. Calder

The Springhill coalfield is situated on the southern limb of the Athol Syncline, the major structural feature of the Cumberland coal basin. The coalfield occupies an area of at least 80 km^2, however the western limits of coal deposition have not been defined due in part to the great depth of seams. The coal measures, which are extensively deformed by the Windsor Group evaporite Black River diapir, attain a thickness of 1300 m at Springhill. Hacquebard and Donaldson (1964) assigned the strata a Westphalian B age on the basis of palynological studies.

Extensive diamond-drilling programs within the Springhill coalfield (Calder, 1980, 1981, 1982; Calder and Naylor, 1983; Norwest Resource Consultants Ltd., 1981) have allowed detailed correlations of coal seam stratigraphy. This information forms the foundation of sedimentological and stratigraphic research which the writer is currently conducting as part of his M.Sc. degree at Dalhousie University, Halifax, under the direction of M.R. Gibling. This review contains a summary of the individual facies types that have been indentified, with a more specific account of coal seams and major sandstones. Models of basin fill evolution and architecture are postulated based upon observed facies assemblage distribution, environmental reconstructions and paleocurrent data; further work is required to corroborate the application of these theories throughout the Cumberland coal basin.

SEDIMENTARY FACIES

The following is a partial list of facies types recognized within the coalfield, together with the interpreted subenvironments. The mere existence of any one facies does not unequivocally define a depositional subenvironment, but can be more confidently interpreted when integrated within a detailed framework of related facies, including three-dimensional configuration of the coal seams.

	FACIES TYPE	DEPOSITIONAL SUBENVIRONMENT
(a)	Clast-to-matrix-supported pebble and cobble extraformational conglomerate	DAFB
(b)	Grey, poorly sorted, feldspathic, conglomeratic sandstones commonly interbedded with indurated siltstones	DAFB
(c)	Grey, coarsening upward, well to moderately sorted, fine- to coarse-grained sandstones (moderately immature, and not commonly developed)	LD
(d)	Grey, indurated, rhythmically laminated siltstone	LD/IB
(e)	Grey, bivalve-bearing arenaceous limestone	LS
(f)	Pale grey, well sorted sandstone, typically trough crossbedded, fine- to coarse-grained with common mud clasts and abandoned mud filled channels	MF

(g)	Pale grey, moderately sorted, feldspathic granule conglomerate to conglomeratic sandstone channel scours with common mud and siderite clasts	MF, DAFB
(h)	Pale grey, well sorted, fine grained sandstone with well developed climbing ripple laminae	MF
(i)	Parallel laminated, thinly interbedded, pale grey, fine grained sandstone and dark grey mudrocks	MF
(j)	Intermediate to bright black vitrain-rich "rider" coal seams (approximately 0.30 m thick)	VL
(k)	Dark grey massive/bioturbated mudstone with tan siderite nodules (rhizoconcretions)	AFP
(l)	Stigmarian-rooted seatearths of varying grain size (mud to sand)	VL, AFP
(m)	Thick, intermediate to bright, normal banded clarain-rich coal seams	AFP
(n)	Dark grey mudstone with horizontal laminar to lenticular siderite	AFP
(o)	Thin discontinuous argillaceous limestone with cone-in-cone structures	AFP
(p)	Mottled red-brown and green-grey mudstone	WDFP
(q)	Red-brown mudstone (massive)	WDFP

KEY

DAFB	distal alluvial fan braidplain
LD	lacustrine delta
IB	interdistributary bay
LS	lacustrine shoreline
MF	meandering fluvial
VL	vegetated levee
AFP	alluvial flood plain
WDFP	well-drained flood plain

COAL SEAM GEOLOGY

Coal seams at Springhill provide accurate reference horizons for interpreting the depositional history of the associated coal measures. In addition, petrographic evaluation of the coals provide insight into paleoecological conditions within and affecting the development of the peat swamps. The coal seams were deposited in elongated peat swamps bordering a braidplain/alluvial fan system developed on the northern border of the Cobequid Highlands to the south. Further to the north, deposition appears to have been controlled, at least partially, by a longitudinally-flowing trunk fluvial system. The centre of maximum uninterrupted peat accumulation in successively younger coal seams migrated toward the south, recording progressive onlap toward the Cobequid Highlands.

The mode of seam termination along the southern and northern margins of deposition differs significantly, because of differences in the depositional environments in those areas. The southern margin of the peat swamps was controlled mainly by distal alluvial fan geomorphology and sedimentation patterns. The seams split and also deteriorate rapidly through lithification, an effect of continual minor detrital influx. The horizon at the base of the No. 3 seam is tentatively correlated with a caliche paleosol inferred to have been developed beyond the southern margin of peat accumulation at a higher well drained topographic position on the distal alluvial fan system. To the north, in contrast, the coal seams were influenced by a less well understood major trunk fluvial depositional system. Here the seams exhibit extensive splitting along the northern margin of deposition, with only a slight increase in inorganic detrital contamination.

Microscopic petrographic examinations of the Nos. 2 and 3 seams by Hacquebard et al. (1967) indicated a forest moor depositional environment. Such an environment of peat accumulation is considered to be compatible with the interpreted depositional milieu of the coalfield as discussed herein. Quantitative assessment by the writer of macerals within the Rodney seam agrees closely with the findings of Hacquebard et al. (1967). The vitrinite content of the seam was found to be 76%, and the inertinite and exinite contents were 18% and 16% respectively. Figure 1 is a photomicrograph of the Rodney seam illustrating the high vitrinite content characteristic of Springhill coals.

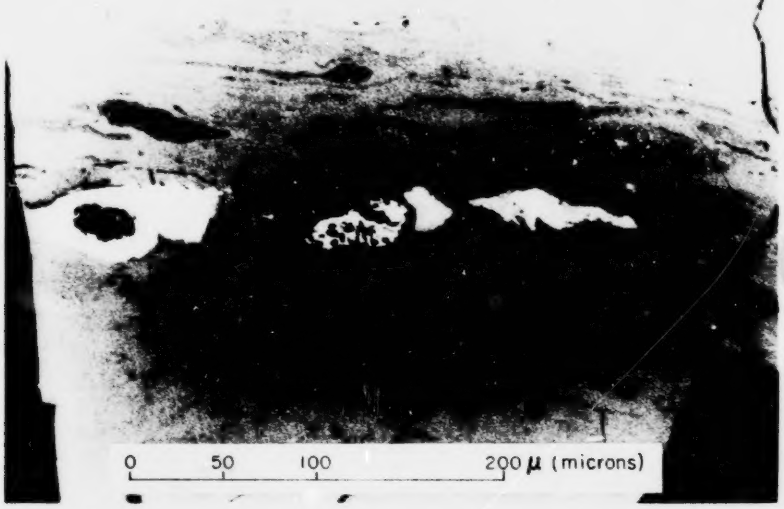

Figure 1. Photomicrograph of Rodney seam showing dominant vitrinite content (grey ground mass). Large bodies of high reflectivity represent sclerotinite of the inertinite maceral group.

RODNEY SANDSTONE

Major multibed sandstone bodies overlying most of the major coal seams at Springhill are similarly interpreted as meandering river deposits, by interpretation from stratigraphic sections incorporating detailed diamond drilling within the coalfield. The opportunity of studying the detailed geometry and facies relationships is rare due to the scarcity of outcrop sections. One notable exception is the Rodney sandstone, a major sandstone approximately 25 m thick, overlying the Rodney coal seam. This unit was exposed throughout the latter phases of open-pit mining of the Rodney seam by Novaco Limited during 1982-83.

The base of the sandstone is subhorizontal, gently undulating with only minor scouring of the siderite-banded mudstone which directly overlies the Rodney seam. The sandstone unit is characterized by abundant trough cross-stratified beds with basal channel lag commonly rich in coalified plant fossils *(Cordaites* sp., et al.), fining upward to thin tabular beds frequently with climbing ripple, and occassionally foreset lamination. Channel abandonment is commonly preserved as mud-filled channel plugs, or as mud drapes which conform with previous topographic features. This facies suite is interpreted as meandering river deposition with frequent chute-channelling of point bars transitional in places to braided channels.

BASIN ARCHITECTURE

The complex interactions and evolution of the subenvironments within the Springhill coalfield cannot be discussed within the scope of this paper, however, the framework of the writer's depositional model in terms of basin architecture is summarized in Figure 2. The configuration

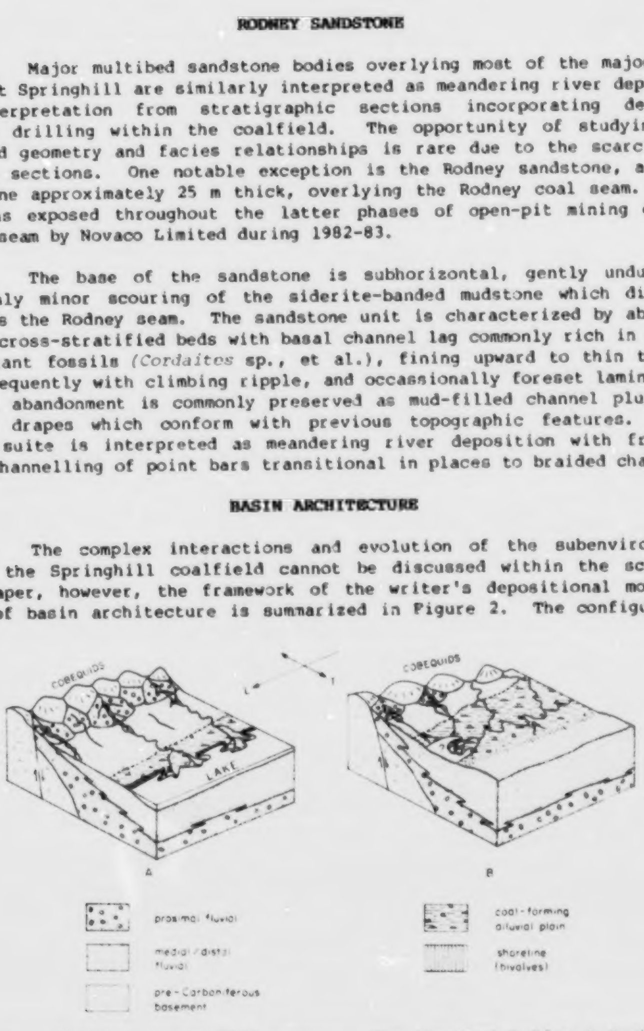

Figure 2. Possible basin fill patterns for the Westphalian B Cumberland coal basin and Springhill coalfield, after examples by Miall (1981). Figure 2A represents early transverse dominated fluvial basin with bivalve shoreline facies. Figure 2B represents later longitudinal dominated fluvial basin. (Not to scale).

of early drainage patterns of the coal measures is inferred to have been dominantly transverse. During this time, deposition was derived from proximal alluvial fans and from associated distal braidplains coalescing on a semimature alluvial plain. Through time, a transition to singular fluvial systems took place with continued transverse flow. Toward the basin's centre, distal subordinate lacustrine or flood basin systems existed in which minor deltaic deposition occurred. Bivalves probably mark the perimeter of this inferred "lacustrine" (subaqueous) environment (Calder, 1981).

As the Cobequid Highlands shed more sediment and the basin filled, the transverse dominated flow gave way to dominantly longitudinal flow with one or more major meandering fluvial systems. Deposition was then characterized by rapid lateral accretion through avulsion on a mature alluvial plain bordering a stagnant mature alluvial fan system. Occasionally, rogue transverse ephemeral streams invaded the coal-forming forest moor bordering the alluvial fans.

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SPRINGHILL COALFIELD DIAMOND-DRILL PROGRAM

R. Naylor, J. H. Calder and S. Chesal

During 1983, diamond drilling in the Springhill coalfield (Fig. 1) was primarily directed towards the outlining of potential open-pit sites to maintain coal markets developed by the Novaco Rodney open-pit mine.

The drill programs were carried out between May and November using a Longyear 88 operated by Paul Hiltz and Ken Rogers of the Nova Scotia Department of Mines and Energy Drilling Division. The following five diamond drilling projects were undertaken:

1. Diamond drilling of the No. 3 seam crown pillar to investigate its potential as an open-pit site
2. Split-tube drilling of the Springhill coal waste bank overlying the No. 3 seam crown pillar
3. Diamond drilling of the No. 3 seam (upper leaf) at the Novaco open-pit mine site
4. Diamond drilling of a strata control test hole immediately down-dip from the Novaco Rodney seam open-pit mine to be evaluated by the Strata Control Group of the Cape Breton Coal Research Laboratory
5. Investigation of the Nos. 7 and 6 seams north of previous mining

A brief description of the results and present status of each of these programs follows.

NO. 3 SEAM CROWN PILLAR (DECEMBER 1982 - JANUARY 1983, MAY 1983 - AUGUST 1983)

At the close of the 1982 drilling season a program was initiated to detail the remaining reserves left between the uppermost workings of the No. 3 mine and the surface. This block of coal, here defined as the No. 3 crown pillar, was thought to be amenable to a limited open-pit operation.

A total of 39 holes were drilled across the pillar along seven lines resulting in approximately 820 m of drilling. One hole per line was geophysically logged and its coal intersections were sampled.

Table 1 briefly outlines the results of the crown pillar program to date. These results are based upon the 660 m strike length of the potential open-pit site.

Application of mining criteria to the No. 3 crown pillar is presently in progress. Results of this study and a complete report on the crown pillar program should be available in the spring of 1984.

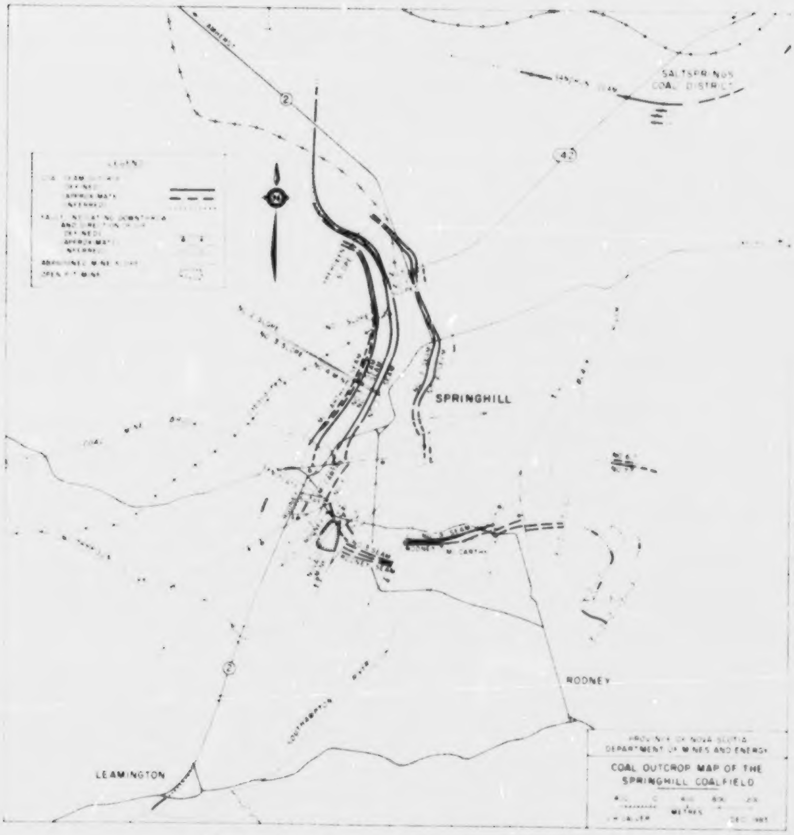

SALTSPRINGS
COAL DISTRICT
2
SPRINGHILL
RODNEY
LEAMINGTON
PROVINCE OF NOVA SCOTIA
DEPARTMENT OF MINES AND ENERGY
COAL OUTCROP MAP OF THE
SPRINGHILL COALFIELD
METRES

Figure 1. The Springhill coalfield.

Table 1. Results of crown pillar drill program over potential open-pit site.

Average seam thickness	3.7 m
Seam dip	29°
Average % ash	11%
Average % sulphur	1.54%
In situ resource tonnage	105 000 t

COAL WASTE BANK (JULY 1983)

The No. 3 crown pillar is overlain over much of its mineable strike length by the coal waste bank of the former No. 2 and No. 4 mines. Open-pit mining of the No. 3 crown pillar would require removal of much of this waste bank. Therefore, a study of the recoverable coal contained within the waste bank was undertaken by the Nova Scotia Department of Mines and Energy's Coal Technologist, Stan Chesal.

A total of 10 split-tube holes (SD83-1 - SD83-10) were drilled through the waste bank totalling 70 m. Each hole was sampled and proximate analysis and washabilities were obtained. Table 2 lists the estimated total tonnage and average proximate analysis of the waste bank based on the 10 split-tube drillholes. The washability results have yet to be completed. A full report is expected in the spring of 1984.

Table 2. Mean proximate analysis and tonnage estimate of Springhill waste bank.

Total Tonnage	Ash	S	Fixed Carbon	Volatile Matter	Calorific Value Btu/lb (calculated)
1 072 573 t	62.22%	1.22%	20.61%	15.51%	4012

No. 3 SEAM NOVACO OPEN-PIT SITE (JUNE 1983 - JULY 1983)

During the late 1950's, a limited bootleg operation was opened on an outcropping of the No. 3 seam east of the Penitentiary Fault, adjacent to the present Rodney open-pit. At the request of Novaco Limited, a drilling program was undertaken to (1) outline the structural boundaries of the No. 3 seam block in which the bootleg working was undertaken, and (2) determine the coal quality.

A total of six diamond-drill holes averaging 20 m in depth were cored. Five holes were geophysically logged, and all seam intersections were sampled. All holes encountered the No. 3 seam.

While the structural boundaries of the seam were adequately defined, more detailed drilling is needed to define some of the minor structural heterogeneities. Coal quality and megascopic descriptions of the No. 3 seam indicate it is nearing its depositional margin in this area. Table 3 lists the volumetrically weighted averages for a proposed mining section on the Novaco open-pit site. A complete in-house report is available through the Coal Section of Nova Scotia Department of Mines and Energy.

Table 3. Volumetrically weighted averages for proposed mining section, No. 3 seam, Novaco open-pit site.

	True Thickness	Ash	Sulphur	Btu's/lb
Mining section upper No. 3 seam	1.53 m	24.04%	2.43%	10 960

STRATA CONTROL HOLE (AUGUST 1983)

At the request of the Strata Control Group of the Cape Breton Coal Research Laboratory, a strata control test hole (SH93) was drilled directly downdip from the Novaco open-pit. This hole was specifically designed to study the rheology of the rock overlying the Rodney seam and its implications to underground mining.

The present usefulness of the core for strata control study is in question because during shipment to Ottawa the truck carrying the core was extensively damaged by fire.

NUMBERS 7 AND 6 SEAMS (SEPTEMBER 1983 - OCTOBER 1983)

As a follow-up to the 1982 drill program on the No. 6 and No. 7 seams, two holes were drilled during September and October 1983. Their purpose was to trace the northward extent of the seams, with a view towards future open-pit mining.

Hole SH94 intersected only coals of poor quality that could not be easily correlated with either the No. 7 or No. 6 seams. To better determine whether the badly deteriorated coals intersected in SH94 were actually the No. 7 and No. 6 seams, SH95 was drilled approximately 100 m further south. Unfortunately, correlation of the seams in SH95 with those in SH94 still proved questionable. No further inventory drilling is planned.

Results of drilling north of old workings on the Nos. 7 and 6 seams has not been conclusive. It appears that the northward extent of the seams could be limited by either a structural or a facies boundary.

Drilling of an inventory nature on the Nos. 7 and 6 seams in the north of the coalfield is not planned at present. A further hole may be drilled in the north, however, to confirm the stratigraphic position of a bivalve-bearing limestone cored in SH95. The presence of this limestone suggests a partial facies equivalence between the coal measures of Springhill and those of Joggins, River Hebert, Chignecto, Saltsprings, and Roslin. It is hoped that as a result of this drilling the northern depositional limits of all the Springhill coals will become better understood.

COAL STUDIES IN CAPE BRETON - 1983

D. J. MacNeil

During 1983, the inventory and evaluation of near surface coal resources in the Sydney coalfield continued. A detailed report on the Tracy seam at Broughton was completed based on the previous year's drilling. Late in the year, a drill program dedicated to making final the inventory of thin seams of the upper *Linopteris obliqua* zone of the Morien Group in the Donkin area was begun.

A reconsideration of the geology of the Richmond basin was begun. Several minor coal occurrences in the Riversdale Group have been exploited in the past. Though of limited extent and complex structure, these showings may suggest other areas in the basin where coal may occur in a less disturbed environment.

A coal occurrence in a small isolated basin of Mabou Formation rocks (the Maple Creek Syncline) east of Glendale, Inverness County, was investigated. Stratigraphic testing of this occurrence is proposed.

In co-operation with personnel of the Cape Breton Coal Research Laboratory of Energy, Mines and Resources, the feasibility of applying geostatistical techniques to coal reserves in the Sydney coalfield is being evaluated. A test case has been prepared and further applications are being investigated.

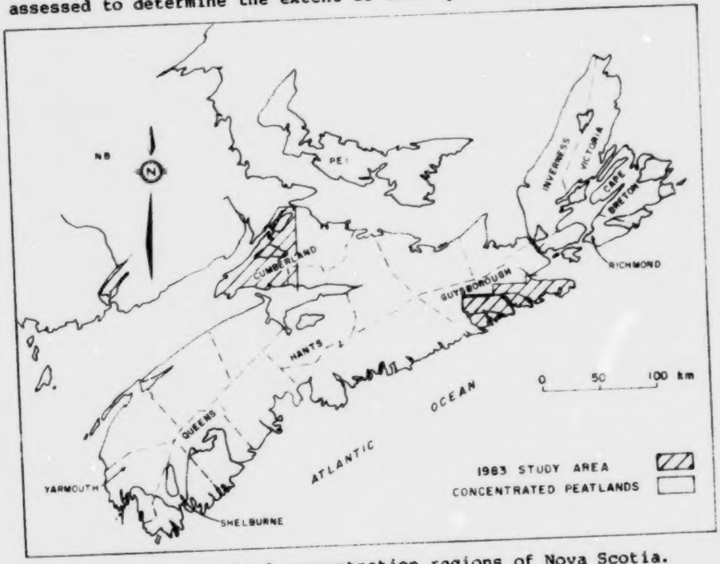
PEATLAND INVENTORY PROGRAM

A. R. Anderson and W. Broughm

INTRODUCTION

Peat is an accepted alternate fuel for energy production in many countries around the world. For several decades, peat fuels have been used at all scales of energy production.

Nova Scotia has about 160 000 ha of peatland (about 4% of the Province) concentrated in five or six regions of the Province (Fig. 1). As part of the ongoing inventory program, Guysborough and Cumberland Counties were assessed to determine the extent of their peat resources.


NB
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0 50 100 km
1983 STUDY AREA ▨
CONCENTRATED PEATLANDS ☐

Figure 1. Peatland concentration regions of Nova Scotia.

PREVIOUS WORK BY THE PROGRAM

SOUTHWESTERN NOVA SCOTIA

This region was first investigated in 1980. By November of 1983, 16 700 ha of peatland had been evaluated, revealing an assessed volume of 370 million m^3 of in situ peat. Relative tonnages (at 50% moisture content) indicate that 62 per cent of the peat evaluated in this region is classified as suitable fuel grade peat (Table 1).

Table 1. Summary of Peatland Inventory results, 1980-1983.

Region	Year	Area Covered (ha)	Average Depth (m)	In situ Volume (x 10^6 m^3)			Tonnage (x 10^6) at 50% Moisture Content* (t)			Per Cent Fuel Peat	
				H_{1-4}	H_{5-10}	Total	H_{1-4}	H_{5-10}	Total	Volume	Tonnage
Southwestern Nova Scotia	**1980	3 614	1.92	29.2	44.8	74.0	4.3	8.5	12.8	61	67
	***1981	6 505	1.79	56.8	78.4	135.2	8.3	14.9	23.2	58	64
	1982	6 606	2.59	79.1	85.9	165.0	11.6	16.3	27.9	52	58
	Average	-	2.10	-	-	-	-	-	-	56	62
	Resource Investigated	16 725	-	165.1	209.1	374.2	24.2	39.7	63.9	-	-
	Resource Estimated	38 000	-	352	446	798	53	90	143	56	63
Hants County	1982	2 237	3.24	51.0	29.0	80.0	7.5	5.5	13.0	36	43
	Resource Estimated	5 851	-	112.3	77.2	189.5	16.4	14.7	31.1	41	47
Halifax County	***1981	225	3.06	6.1	0.7	6.8	0.9	0.1	1.0	10	13
	1982	38	3.09	0.8	0.4	1.2	0.1	0.08	0.18	33	44
Kings County	1982	504	2.19	5.49	5.54	11.03	0.8	1.05	1.85	50	57
	Resource Estimated	4 451	-	48.5	49.0	97.5	7.08	9.30	16.4	50	57
Guysborough County	1983	3 900	2.5	78	20	98	11	4	15	20	27
	Resource Estimated	14 400	-	-	-	360	-	-	54	-	-
Cumberland County	1983	3 500	2.5	65	22	87	9.5	4.2	13.7	25	30
	Resource Estimated	6 700	-	-	-	167	-	-	-	-	-

*Tonnes at 50% moisture content have been calculated using the following conversion factors

H_{1-4} peat 0.146 t per in situ m^3

H_{5-10} peat 0.190 t per in situ m^3

These values have been abridged from: Montreal Engineering Co. Ltd. (1980)

**Anderson and Broughm (1981)

***Anderson and Broughm (1982)

The fieldwork for this region has been completed, and efforts are being directed towards final mapping and development of utilization programs.

HALIFAX COUNTY

In addition to deposits in the central portion of the County studied in 1981, some deposits along the Eastern Shore (Port Dufferin-Quoddy) were assessed in 1982. The deposits were small and quite deep, having about 1 to 1.5 million m^3 of peat in total, of which 44 per cent is fuel grade peat.

HANTS COUNTY

The 1982 inventory covered approximately 2200 ha of peatland in twelve deposits revealing about 80 million m^3 of peat, 36 per cent of which is classed as fuel grade peat. Data from the region indicate a potential for horticultural peat moss development.

KINGS COUNTY

Peat deposits in the Aylesford-Berwick area were assessed in early 1982. Four deposits, including the Caribou Bay (currently under peat moss production), were sampled. The short evaluation program covered 500 ha of peatland resulting in data for 11 million m^3 of peat of which about 50 per cent is fuel grade peat.

AREAS INVESTIGATED 1983

CUMBERLAND COUNTY

The deposits evaluated in this region (Fig. 2), represent approximately 87 million m^3 of peat of which about 25 per cent is classed as fuel grade (H_{5-10}). The bogs are on average 2.5 m in depth, though sometimes reach as deep as 8 m. Data from these peatlands show large amounts of good quality peat moss that could be developed for horticultural use.

The entire County is estimated to have approximately 167 million m^3 peat in approximately 6700 ha of peatland of which about 75 per cent would be classed as suitable horticultural grade (H_{1-4}).

GUYSBOROUGH COUNTY

County soil surveys (Hilchey et al., 1964) indicate 14 400 ha of peatland (excluding salt marshes) in the County. Estimates of total resource show nearly 360 million m^3 of peat (54×10^6 t), the majority of which is quite isolated in small deposits throughout the region. This resource is mainly found south of the Chedabucto Fault ranging from Canso across the Halifax-Guysborough County line.

Specific peat deposits have been evaluated for their peat moss potential in several reports on the Guysborough County resource, the latest of which, Sutherland and Shea, 1976, used water holding capacity, ash

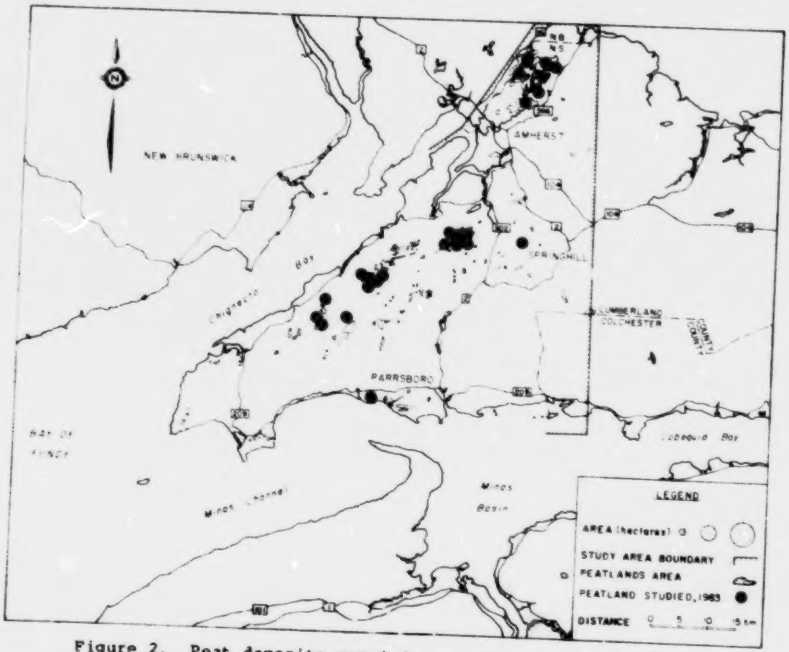
N
NEW BRUNSWICK
NB
NS
AMHERST
SPRINGHILL
Chignecto Bay
PARRSBORO
CUMBERLAND
COLCHESTER
COUNTY
COUNTY
Bay of Fundy
Minas Channel
Minas Basin
Cobequid Bay
LEGEND
AREA (hectares)
STUDY AREA BOUNDARY
PEATLANDS AREA
PEATLAND STUDIED, 1983
DISTANCE 0 5 10 15 km

Figure 2. Peat deposits sampled in Cumberland County, 1983.

content and pH to provide data on peat quality. Data from this report and others will be correlated later with information obtained during this field season.

The relatively small peat deposits in Guysborough County are usually ombrogenic in nature, having well pronounced, poorly humified or peat moss domes. About 150 deposits were sampled through the course of the program (Fig. 3) revealing approximately 98 million m^3 of peat of which 20 per cent can be classified as fuel grade peat (H_{5-10}). The bogs (peat deposits) surveyed were on average 2-3 m deep, with specific sites reaching as deep as 9 m.

In terms of resource, sampled deposits reveal about 11 million t of peat moss and about 4 million t of fuel grade peat. However, due to the isolation of the majority of deposits sampled, only a few could be considered commercially viable. There have been earlier attempts to extract peat moss by dredge and press methods, but at present all have been abandoned because of high operational costs.

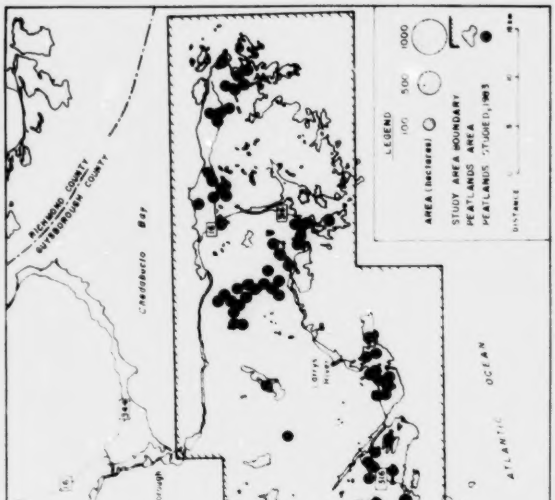
LEGEND
AREA (hectares)
100
500
1000
STUDY AREA BOUNDARY
PEATLANDS AREA
PEATLANDS STUDIED, 1983
DISTANCE
RICHMOND COUNTY
GUYSBOROUGH COUNTY
Chedabucto Bay
Guysborough
ANTIGONISH COUNTY
GUYSBOROUGH COUNTY
ANTIGONISH COUNTY
PICTOU COUNTY
PICTOU COUNTY
GUYSBOROUGH COUNTY
ATLANTIC OCEAN
Middle Country Harbour
Sherbrooke
St. Marys River

Figure 3. Peat deposits sampled in Guysborough County, 1983.

OTHER STUDIES

REMOTE SENSING

A joint project sponsored by the Nova Scotia Department of Mines and Energy and the Nova Scotia Land Survey Institute is currently underway to assess the potential of using LANDSAT imagery and a Computerized Image Analysis system for mapping peatlands in southwestern Nova Scotia.

Methodology developed in this project will hopefully allow computerized mapping of peat deposits across the Province. Eventually these techniques may be used in other mapping programs across Canada. The final product will be a series of 1:250 000 peatland maps producing regional summaries of the extent and types of peatlands across the Province.

SUMMARY

To date the Inventory Program has covered a total of 27 000 ha of peatlands on mainland Nova Scotia. The volumes associated with this total area are: 65 million m^3 horticultural grade peat (H_{1-4}) and 22 million m^3 fuel grade peat (H_{5-10}). These volumes equate to 9.5 million t of peat moss at 50 per cent moisture content and 4.2 million t of fuel peat under the same conditions.

Extrapolation of these data provides estimates of resource in the studied regions of 18 million t peat moss and 8 million t fuel peat (at 50% moisture content) to date.

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Hilchey, J. D., Cann, D. B. and MacDougall, J. I.
1964: Soil Survey of Guysborough County, Nova Scotia; Canada Department of Agriculture and Nova Scotia Department of Agriculture and Marketing, Nova Scotia Soil Survey, Report No. 14.

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Sutherland, D. R. and Shea, F. S.
1976: Assessment of peat moss occurrences in Guysborough, Antigonish, Pictou, Colchester and Cumberland Counties, Nova Scotia; Reprinted from Peat Moss Project, Atlantic Regional Development Agreement, pts. 1-3, 1964-66; Nova Scotia Department of Mines and Energy, Bulletin 3.

EXPLORATION MONITORING ACTIVITIES

J. M. McMullin

Monitoring of mineral exploration activity is carried out by the Resource Geology Section of the Mineral Development Division. The purpose of the activity is three fold. First, it provides the Department with an up-to-date awareness of current activity, of changing trends and of the general health of the mineral exploration industry in the Province; second, it enables the preparation of annual summaries of exploration programs for reference purposes; and third, it provides a direct liaison between government and industry at the field and exploration office levels.

Monitoring of exploration is carried out by means of visits and phone calls to company geologists at offices and exploration sites, by reviewing licences issued and areas staked, by reviewing assessment and other reports submitted to the Department, and by liaising with exploration personnel at functions and conferences which are oriented towards the exploration industry. An annual survey or census of exploration is also conducted that identifies, summarizes and categorizes exploration work according to commodity, methods, type of claim holder and costs. It should be noted that statistical tables are for 1982 and the remainder of the report covers 1983.

During 1983, exploration monitoring was carried out from the Stellarton office. Many of the active exploration sites were visited at least once, particularly where drilling was being conducted, and all the active mining and exploration companies were contacted.

MINERAL EXPLORATION ACTIVITY IN 1983

The total number of claim/licence holders averaged about 200 throughout 1983. Of these, about 20 were major mining companies and about 15 were market-financed exploration companies or groups of companies. The remainder were private companies, consultants, promoters, prospectors and other individuals.

Nine major mining companies maintained offices in the Province in 1983. Of these, six were regional offices responsible for exploration in other parts of the Atlantic Provinces in addition to Nova Scotia. Nine exploration companies or groups maintained either main offices or field offices during all or most of 1983. Of these, four were Nova Scotia based organizations.

One major company (Granges Exploration AB) established an office during 1983 and another (Billiton Canada Inc.) announced its Nova Scotia office will be closed as of February 1984. Billiton's Nova Scotia exploration will be carried out from the Fredericton, New Brunswick office.

During 1983, approximately 1328 exploration, development, and special licences were issued or renewed covering about 45 700 claims, equivalent to about 14% of the area of the Province. This represents a small increase over 1982 (Table 1).

Table 1. Mineral exploration trends in Nova Scotia.

	1976	1977	1978	1979	1980	1981	1982	1983*
Assessment Work Reported For Licence Renewals ($)*	1 600 000	3 800 000	5 900 000	4 700 000	7 564 000	8 441 270.30	4 107 273.20	4 200 210.58
Total Licences Issued	1 489	2 894	2 393	1 841	2 559	1 896	1 205	1 328
Claims Recorded								
General (base metals, gold, etc.)	35 434	70 936	38 597	40 497	88 703	72 907	40 084	40 630
Uranium	21 526	48 721	31 978	30 920	25 483	6 225	0	0
Salt, Potash	224	887	1 148	2 256	13 505	1 155	656	505
Coal							3 072	4 565
No. Mineral Assessment Reports	70	95	132	126	140	157	124	188

*Preliminary figures

The level of exploration activity as measured by exploration expenditures was also moderately higher in 1983 than in 1982. Although firm figures are not yet available, it is estimated that expenditures for work carried out during 1983 will total about $7 million and that figures for diamond drilling will be similar to those for 1982. This compares with expenditures of $5.5 million in 1982 and $14.6 million in 1981. It is anticipated that the 1983 level of activity will be maintained during 1984, but gold exploration may be erratic unless the outlook for gold prices improves.

Gold, tin and tungsten, barite, base metals and coal were again the most sought-after minerals in Nova Scotia in 1983 (excluding offshore oil and gas exploration), whereas no exploration was done for either potash or uranium. Exploration for industrial minerals such as limestone, dolomite, gypsum, silica sand, clay and methane (coal degasification) was modest.

Locations of most of the exploration programs carried out in 1983 are shown on Figure 1.

GOLD EXPLORATION

As interest rates declined in the fall of 1982, and stockmarkets and gold prices improved, so did the level of exploration activity for gold. Most gold exploration was carried out by junior mining and exploration companies with intermittent funding. Some major mining companies active in Nova Scotia are shifting their emphasis to precious metals. Exploration was concentrated on the 19th century gold districts, which occur mostly within the Cambro-Ordovician Meguma Group of metasedimentary flysch sequences. These are primarily located in the Atlantic coastal counties of mainland Nova Scotia (Guysborough, Halifax, Lunenburg, Queens and Yarmouth Counties) and in Hants County.

A Vancouver based group has brought new investment to several claim groups optioned from the Harry Morgan-Avard Hudgins group of companies (M.E.X. Exploration and others). The bulk of this work was done by Outland Resources Corp. around the old Highland gold property at Widow Point, located on Country Harbour in Guysborough County. Geochemical and geophysical surveys were carried out, along with auger drilling, diamond drilling and trenching. A mobile test mill was also set up on the property to test small bulk samples. Acadian Gold Mines, in association with M.E.X., diamond drilled in the Beaver Dam Gold District in Halifax County, while the third member of the group, the Bear Pass Resources Corp., did preliminary surveys in the Leipsigate and Pleasant River Barrens areas of Lunenburg County. Outland Resources Corp. also carried out preliminary geological, geochemical and geophysical surveys at Mt. Uniacke, Hants County, at Sheet Harbour, Halifax County and at Miller Lake and Crows Nest, Guysborough County.

Goldenville Explorations Ltd. carried out a 6000 m (55 holes) diamond drilling program and gradiometer surveys in the Goldenville Gold District, Guysborough County, between March and November. This is the most important of all the old gold districts, with total production exceeding 200 000 oz. of gold. Goldenville's parent company, Northumberland Mines,

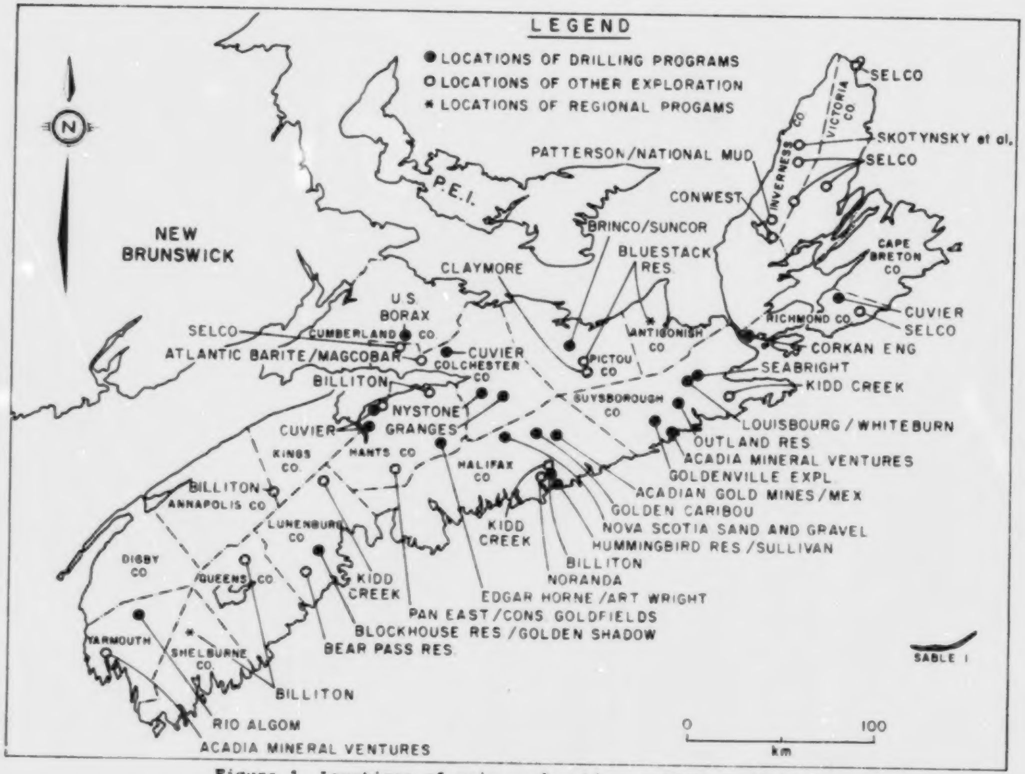

LEGEND
● LOCATIONS OF DRILLING PROGRAMS
○ LOCATIONS OF OTHER EXPLORATION
* LOCATIONS OF REGIONAL PROGAMS
N
NEW BRUNSWICK
P.E.I.
SELCO
SKOTYNSKY et al.
SELCO
PATTERSON/NATIONAL MUD
CONWEST
BRINCO/SUNCOR
BLUESTACK RES.
CLAYMORE
U.S. BORAX
SELCO
ATLANTIC BARITE/MAGCOBAR
CUVIER
BILLITON
NYSTONE
CUVIER
GRANGES
CUVIER
SELCO
CORKAN ENG
SEABRIGHT
KIDD CREEK
LOUISBOURG / WHITEBURN
OUTLAND RES
ACADIA MINERAL VENTURES
GOLDENVILLE EXPL.
ACADIAN GOLD MINES/MEX
GOLDEN CARIBOU
NOVA SCOTIA SAND AND GRAVEL
HUMMINGBIRD RES./SULLIVAN
BILLITON
NORANDA
KIDD CREEK
EDGAR HORNE/ART WRIGHT
PAN EAST/CONS GOLDFIELDS
BLOCKHOUSE RES./GOLDEN SHADOW
BEAR PASS RES.
KIDD CREEK
BILLITON
BILLITON
RIO ALGOM
ACADIA MINERAL VENTURES
INVERNESS CO
VICTORIA CO
CAPE BRETON CO
RICHMOND CO
ANTIGONISH CO
PICTOU CO
GUYSBOROUGH CO
CUMBERLAND CO
COLCHESTER CO
HALIFAX CO
HANTS CO
KINGS CO.
ANNAPOLIS CO
LUNENBURG CO
QUEENS CO
DIGBY CO
SHELBURNE CO.
YARMOUTH
SABLE I
0
100
km

Figure 1. Locations of main exploration programs, 1983.

has been conducting heap leaching feasibility studies on the nearby Cochrane Hill deposit.

In the Forest Hill Gold District in Guysborough County, Seabright Resources Inc., of Halifax continued an extensive program of large scale trenching, geophysics and diamond drilling during the early part of the year. This company is also actively engaged in feasibility studies preparatory to reclaiming gold from old stamp mill tailings in many of the old gold districts around the Province.

Adjacent to Forest Hill, additional diamond drilling and basal till sampling were carried out in January at Mile Lake by Louisbourg Property Holdings and Whiteburn Precious Metals Ltd., under the guidance of Dr. John Riddell. Also in Guysborough County, the Wine Harbour Gold District was diamond drilled by Acadia Mineral Ventures (Avard Hudgins).

Caribou, Halifax County, was the scene of an underground dewatering and rehabilitation project carried out during the second half of the year by Golden Caribou Explorations Inc. The Holman Mine, which was operated until 1947 by Cominco, was one of the largest producers in the Province. Underground drilling, sampling, and mapping were carried out under the supervision of James Tilsley and Associates. The adjacent Lake Mine property, under the same sponsorship and management, was subjected to deep diamond drilling by Lake Mine Resources Inc., following magnetic and VLF-EM surveys. Isaacs Harbour Gold Explorations Inc. carried out a program of geophysics in the Isaacs Harbour Gold District, Guysborough County.

In Halifax County, Sullivan Mining Group optioned a claim group at Tangier from Hummingbird Resources Ltd. and conducted a short diamond drilling program. Diamond drilling and geophysics were also carried out by Golden Shadow Resources Inc. on Blockhouse Resources Ltd. ground in the Blockhouse Gold District, near Mahone Bay in Lunenburg County. Additional drilling was carried out by Art Wright on claims held by Edgar Horne and Byron Taylor at Renfrew Gold District, Hants County. The nearby Mt. Uniacke Gold District was investigated by mapping, sampling and trenching by Pan East Explorations Inc. and Consolidated Gold Fields. Pan East also carried out reconnaissance mapping in the Fifteen Mile Stream area and geochemical surveys in the Killag Gold District, both in Halifax County.

In other geological environments, U.S. Borax and Chemical Corp. carried out a short diamond drilling program near Williamsdale, Cumberland County in the Cobequid Mountains. This gold-silver-arsenic prospect is associated with a Silurian volcanic/sedimentary sequence.

The Outland Resources-Bear Pass Resources group, in association with John Skotynsky, and Selco Inc., each investigated areas of the Cape Breton Highlands for precious metals associated with polymetallic sulphide occurrences.

The potential for fossil placer deposits along the margins of the Rawdon Hills was examined by Avard Hudgins and partners.

In addition to mining and exploration companies, a number of prospectors continued to explore for gold throughout the Province, principally in the Meguma, using means ranging from panning to shaft sinking.

TIN AND TUNGSTEN EXPLORATION

Exploration was quite active during the year, most of it conducted by the exploration divisions of several major mining companies. Rio Algom Mines Ltd. (through Riocanex Inc.), Billiton Canada Ltd., Kidd Creek Mines Ltd. and Selco Inc. were the most active, but only the first two did any drilling. Noranda Exploration Co. Ltd. carried out some field work. The main thrust for this exploration has been towards areas intruded by specialized granites and late granitic differentiates, particularly where strong hydrothermal alteration and fracturing have occurred.

Rio Algom has concentrated its efforts in Yarmouth County, in the area surrounding its East Kemptville tin orebody. Production from the orebody is scheduled for 1986. In addition to some continued detailed diamond drilling on the orebody itself in January, diamond drilling, overburden drilling, geophysics and trenching were also carried out on other targets. Geophysical work included IP, scintillometer, gravity and magnetic surveys.

Billiton was busy in their first full year of exploration in the Province operating a large regional grassroots geochemical program on an 8000 claim block in Shelburne, Yarmouth, and Queens Counties.

Billiton also did considerable detailed work on the Caledonia, Queens County property acquired from Shell Canada Resources in 1982. Detailed mapping, prospecting and geophysical surveys (magnetometer, VLF-EM, I.P./resistivity and gravity) were carried out.

Preliminary ground surveys were also conducted by Billiton on claims near East Dalhousie (Kings and Annapolis Counties).

The Ship Harbour-Lake Charlotte-Tangier Grand Lake area of Halifax County, underlain by part of the Musquodoboit Batholith, was explored by Billiton, who diamond drilled late in the year, and by Kidd Creek Mines Ltd. and Noranda Exploration, who each conducted geochemical work.

Kidd Creek was also active in the Sangster Lake area of Guysborough County and in the Manganese Mines area of Lunenburg County. Selco Inc. concentrated their work on several properties in the Cape Breton Highlands.

BASE METAL EXPLORATION

Activity was at about the same modest level as 1982. Selco Inc. held several large properties in the Cobequid Mountains of northwestern mainland Nova Scotia and the Cape Breton Highlands, and staked a large group of claims covering most of the Stirling volcanic belt in the Precambrian Fourchu Group of southeastern Cape Breton Island, where a Questor Input survey was flown during the fall. Other claim holders in the Stirling belt include Doug Hunter and Lloyd Nelson (Lloydex), who have mineral rights to the former Stirling Mine property, and Craig Miller (Prospex Inc.). Selco's exploration of the Devonian volcanics in the Cobequids consisted of stream sediment geochemical surveys, lithogeochemistry and geological mapping.

Granges Exploration AB carried out additional diamond drilling on the Smithfield Mine property located on the Windsor-Horton contact (Carboniferous basin) near Middle Stewiacke, Colchester County.

The basal Windsor was also investigated by Billiton at Newcomb Corner, Halifax County and Latties Brook, Hants County (geological mapping), at Smithfield, Colchester County and Walton, Hants County (overburden drilling) and near Noel Lake, Hants County (geophysics and diamond drilling).

Bluestack Resources Ltd., operator of a joint venture with Selco, continued a regional geochemically-oriented base metals and barite exploration program in Pictou and Antigonish Counties.

BARITE EXPLORATION

Increased offshore drilling for oil and gas has spurred the search for more commercial deposits of barite. Many known occurrences are found in the Carboniferous Basins, where they are often associated with base metals; therefore, some of the barite exploration programs are also oriented towards base metals.

Drilling has been carried out by Cuvier Mines Inc. at Pine Brook, Richmond County (adjacent to the new Novex Mining and Exploration Ltd. barite mine), at Lower Burlington and near Walton in Hants County, and at Londonderry, Colchester County. Magcobar Dresser Canada drilled on the Atlantic Barite Co. Ltd. claims near Bass River, Colchester County and also took out a bulk sample. Bulk sampling was also carried out by National Mud Control Ltd. on the R. Patterson claims at Scotsville, Inverness County, which were explored by CCH Minerals (Campbell Resouces) in 1982.

INDUSTRIAL MINERALS EXPLORATION

Nova Scotia Sand and Gravel Ltd. continued exploration work, including drilling, for silica sand deposits of Cretaceous age on properties at McPhees Corner, Hants County, and Elmsvale, Halifax County. These Cretaceous deposits of silica sand and clay were also the subject of special surveys and drilling by the Nova Scotia Department of Mines and Energy in the Musquodoboit Valley and near Whycocomagh, Inverness County.

COAL AND METHANE EXPLORATION

Exploration for new coal resources was continued by the Brinco Mining Ltd.-Suncor Inc. joint venture at New Glasgow, Pictou County, with Suncor as operator of a program which included shallow seismic surveys and diamond drilling in an area where no previous mining has been done. Also in New Glasgow, coal demethanization testing was continued in the well drilled in 1982 by Novacorp Engineering Services (a subsidiary of Nova, an Alberta Corporation). This well was cleaned and deepened in 1983 and further testing is continuing to evaluate the potential of commercial production. Coal demethanization tests were also carried out at the Devco coal mines in Cape Breton.

Exploration for coal was also carried out by the Nova Scotia Department of Mines and Energy at Springhill, Cumberland County, in the Westville-New Glasgow area of Pictou County and the Donkin area, Cape Breton County.

OIL AND GAS EXPLORATION

An onshore program of wildcat oil and gas exploration drilling commenced in the late summer in the Strait of Canso area. Drilling will continue in 1984 at a number of sites in the northeastern mainland and on Cape Breton Island. This work is being carried out by Corkan Engineering of Canada Ltd.

MINING DEVELOPMENT

BASE METALS

The East Kemptville, Yarmouth County tin deposit that Rio Algom purchased from Shell Canada Resources in 1982 will be brought into production by late 1985. Preconstruction drill tests are underway with construction slated for the spring of 1984. A milling rate of 9000 t per day is planned with annual yields of 4500 t of tin concentrate, 1500 t of copper concentrate and 2400 t of zinc concentrate. The estimated cost of bringing this 56 million t open-pit operation into production is $150 million.

PRECIOUS METALS

Northumberland mines has completed heap leach tests at its Cochrane Hill, Guysborough County gold mine and is planning an open-pit/heap leach operation.

BARITE

Novex Mining and Exploration Co. is upgrading its milling facility at Lake Enon, Cape Breton County, to provide drill mud grade barite from its recently opened quarry at Pine Brook. Conwest Exploration Co. completed bulk sample milling tests and some feasibility studies on its Lake Ainslie, Inverness County barite-fluorite deposit and is proceeding with other predevelopment arrangements. Nystone Chemicals completed development drilling required to permit the company to produce drilling mud grade barite as well as pharmaceutical barite from its Upper Brookfield, Colchester County deposit.

GYPSUM

Georgia-Pacific began a development drilling program on its gypsum deposit at Sugar Camp, Inverness County, in preparation for moving operations from its existing quarry at River Denys. Little Narrows Gypsum continued with development of reserves adjacent to its quarry at Little

Narrows, Victoria County and Canada Cement Lafarge opened a small quarry at Upper Brookfield, Colchester County to supply gypsum for its cement plant at Brookfield.

COAL

Cape Breton Development Corporation is continuing with the development of its Donkin undersea mine in Cape Breton County. Production is scheduled to begin in the late 1980's and reach full production of 3 million t per year by the mid 1990's. A 7.4 m diameter tunnel boring machine is presently enlarging tunnels bored by a smaller machine. More than 3 km of the main haulage slope remains to be driven using the larger boring machine.

Pentum Mining and Development Ltd. has been given an eighteen month special licence to perform underground development on the Rodney seam at Springhill, Cumberland County, and mine up to 20 000 t of coal for testing purposes. This seam had been operated in early 1983 by Novaco, a provincial Crown Corporation that had extracted 70 000 t from a boxcut operation.

STATISTICS FOR 1982 EXPLORATION

Tables 2, 3, and 4 show compilations summarizing mineral exploration in Nova Scotia. The data are based on figures supplied by the mining industry and prospectors during the 1982 annual census. Forms entitled, "Reports of all Physical Work and Surveys Performed in the Province of Nova Scotia" (otherwise known as "Blue Forms") were distributed in mid-December 1982 to all licence and lease holders and to nonmineral mine operators such as gypsum and limestone producers. Approximately 310 forms were sent out, of which 169 were returned. Of the 169 returned, 93 reported that exploration or development work had been carried out during the year. For a complete breakdown of the types and costs of exploration work conducted by different categories of licence holders, and for different categories of minerals (and nonminerals), please refer to Tables 2, 3 and 4. It is readily apparent from Table 4 that nearly 90 per cent of exploration work is carried out by mining and exploration companies, although this group makes up only approximately 25 per cent of all licence holders (and other operators) (Tables 5 and 6 show the companies active in exploration in Nova Scotia during the period 1981-83). It is also evident that about half of all licensees (identified as Prospectors and other Individuals) only carry out about 1 per cent of all exploration activity. For this reason, the latter category will not be surveyed in the same detail in the future.

Response from those active in exploration was good, and valuable suggestions were received from several respondents to further improve the census. Active monitoring of exploration activity during the year permitted the identification of projects so that in the few cases where work had been carried out but not reported, figures were obtained from assessment reports or by other follow-up, and included in the totals to give as accurate a computation as possible.

Statistics for the four largest categories of minerals for which exploration was carried out (tin and tungsten, gold, coal, and base metals) are also presented in more detail in Table 7.

Table 2. Mineral exploration, 1982.

		EXPLORATION			DEVELOPMENT			COMBINED
% OF TOTAL		DOLLARS	HOLES DRILLED	METRES DRILLED	DOLLARS	HOLES DRILLED	METRES DRILLED	TOTAL DOLLARS
26 %	TIN, TUNGSTEN	$ 1 451 225	74	7 098	$ 218 000	8	824	$ 1 669 225
27 %	GOLD	1 483 875	53	5 632	660 000	-	-	2 143 875
26 %	COAL	1 441 075	61	5 158	18 100 000	2	308	19 541 075
13 %	BASE METALS	669 025	47	6 232	1 500	4	100	670 525
4 %	BARITE	244 750	51	1 102*	100 000*	-	-	344 750*
2 %	MISCELLANEOUS OR UNSPECIFIED	115 325	-	-	-	-	-	115 325
1 %	POTASH, SALT	84 150	N/A	185	70 600	-	-	154 750
1 %	LIMESTONE, DOLOMITE	43 250	53	987*	-	-	-	43 250
	GYPSUM	10 800	11	220	1 841 800	13	427	1 852 600
	SILICA, CLAY, FELDSPAR	6 775	-	-	67 000	-	-	73 775
	GRANITE	2 425	2	35	-	-	-	2 425
100 %	TOTALS	$ 5 552 675	352	26 649	$ 21 058 900	27	1,659	$ 26 611 575
1981 COMPARISONS		$ 14 607 662	579	68 118	$ 8 758 567	156	14,671	$ 23 366 229

Note Dollar figures are rounded off to the nearest $25.
* c[illegible]imate figures
Re[illegible] December 15, 1983, February 14, 1984

NOVA SCOTIA DEPARTMENT OF MINES AND ENERGY
Data based primarily on figures obtained from the provincial annual census, "Reports of all physical work and surveys performed in the Province of Nova Scotia"

Table 3. Summary of all exploration activity in Nova Scotia, 1982 (excluding conventional and offshore oil and gas).

Type of Mineral Sought	Diamond-drill Holes		NATURE AND COST OF WORK PERFORMED							% of Total
	Number	Depth m	Diamond Drilling $	Geological Surveys $	Geochemical Surveys $	Geophysical Surveys $	Airborne Geophysical Surveys $	Other works $	**TOTAL $**	
Gold & Silver	53	5 632	306 075	762 410	257 219	40 997	---	117 184	**1 483 885**	26.7%
Tin & Tungsten	74	7 098	520 386	213 461	366 574	164 227	77 500	109 083	**1 451 231**	26.1%
Coal & Methane	61	5 158	892 307	88 135	7 110	179 909	---	273 618	**1 441 079**	25.9%
Base Metals	47	6 232	376 677	87 102	109 618	30 014	24 331	41 283	**669 025**	12.0%
Barite	51	1 102*	68 000	50 950	77 064	2 737	---	45 998	**244 749**	4.4%
Misc. or Unspecified	--	--	--	58 972	40 000	---	---	16 350	**115 322**	2.1%
Salt & Potash	N/A	185	10 078	29 571	493	44 020	---	---	**84 162**	1.5%
Limestone & Dolomite	53	987*	37 197	6 068	---	---	---	---	**43 265**	0.8%
Gypsum	11	220	1 000	---	---	---	---	9 786	**10 786**	0.2%
Silica, Clay, Feldspar	--	--	---	6 550	230	---	---	---	**6 780**	0.1%
Granite	2	35	2 430	---	---	---	---	---	**2 430**	--
TOTAL	**352**	**26 649**	**$2 214 150**	**$1 303 219**	**$858 308**	**$461 904**	**$101 831**	**$613 302**	**$5 552 714**	
% OF TOTAL			40%	23.5%	15.5%	8%	2%	11%		

*approximate figures

Table 4. Summary of exploration work by category of licence holder, 1982 calender year.

Category of Licence Holder or Operator	1982 CENSUS			DIAMOND-DRILL HOLES		NATURE AND COST OF WORK PERFORMED						TOTAL $	% of Total	Average $ work per active respondent
	Number of Questionnaires Distributed	Number of Questionnaires Returned	Number Reporting Work	Number	Total Length (m)	Diamond Drilling $	Geological Surveys $	Geochemical Surveys $	Geophysical Surveys $	Airborne Geophysical Surveys $	Other Works $			
Major Mining Cos. (Large Operators and Producers)	51	41	29	170	16 335	1 661 309	537 529	554 034	370 189	101 831	436 957	**3 661 849**	65.9%	126 270
Exploration Cos. (Dependent on Risk Capital Financing)	32	26	11	55	4 646	266 331	642 155	292 208	30 349	---	67 126	**1 298 169**	23.4%	118 015
Private Companies, Small Producers, Consultants, Promoters	69	38	16	65	1 239	50 930	88 771	11 966	19 800	---	38 767	**210 234**	3.8%	13 140
Prospectors and other Individuals	158	64	37	4	470	7 845	13 204 +539 man days	100	100	---	15 772 +292 man days	**37 021 +831 man days**	1.3%	1 900
Government (NSDME Coal Evaluations)	N/A			58	3 959	227 735	---	---	41 466	---	43 000	**312 201**	5.6%	
TOTALS	310	169	93	352	26 649	$2 214 150	$1 303 219	$858 308	$461 904	$101 831	$613 302	$5 552 714		

Note: 1) Data based primarily on the annual NSDME census "Reports of all Physical Work and Surveys Performed in the Province of Nova Scotia", with some data from Statistics Canada.

2) Man days of work are considered to be equivalent to $40 each.

Table 5. Major exploration oriented mining companies* active in Nova Scotia

	1981	1982	1983	N.S. Office in 1983
Amax of Canada (now Canamax Resources Inc.)	x	x	-	
Asarco Exploration Co. of Canada Limited	-	-	-	
BILLITON CANADA LIMITED	-	x	x	Dartmouth
Brinco Mining Limited	x	x	-	
Canadian Nickel Company Limited (Inco)	x	-	-	
CCH Minerals Limited	-	x	-	
Chevron Canada Resources Limited	x	x	-	
Cominco Limited	x	-	-	
Conwest Exploration Company Limited	-	x	-	
Dome Exploration (Canada) Limited	x	x	-	
Duval International Corporation	x	x	-	
Eldorado Nuclear Mines Limited	-	-	-	
ESSO MINERALS CANADA	x	x	x	Halifax
Getty Canadian Metals Limited	-	-	-	
GRANGES EXPLORATION AB	x	x	x	Sackville
Gulf Minerals Canada Limited (defunct)	x	-	-	
KIDD CREEK MINES LIMITED	x	x	x	Windsor
Lacana Mining Corporation	x	x	-	New Glasgow
NORANDA EXPLORATION COMPANY LIMITED	x	x	x	
Norcen Energy Resources	x	-	-	
Northgate Explorations Limited (inc. Patino Mines)	x	-	-	
Petro-Canada Exploration Inc.	x	x	-	
Placer Development Limited	x	-	-	
RIO ALGOM MINES LIMITED, RIOCANEX	x	x	x	East Kemptville
Saarberg Interplan Canada Limited	x	-	-	
SELCO INC.	-	x	x	Halifax
Shell Canada Resources Limited (defunct)	x	x	-	
Sherritt Gordon Mines Limited	x	-	-	
Sullivan Mining Group Limited	-	-	x	
Sulpetro Minerals Limited	x	x	-	
SUNCOR INC.	-	x	x	New Glasgow
Uranerz Exploration and Mining	x	-	-	
U. S. Borax and Chemical Corp. (inc. Pacific Coast) (Mines Limited)	x	x	x	Halifax

*Companies whose exploration funds are generated internally.

Companies currently or recently active with continuing or increasing exploration programs are listed in block letter.

Table 6. Exploration companies* active in Nova Scotia

		1981	1982	1983	N.S. Office in 1983
1.	BLUESTACK RESOURCES LIMITED	x	x	x	Truro
2.	Borcan Resources Limited	-	x	x	
3.	Card Lake Copper Mines Limited	x	-	-	
4.	Coxheath Gold Holdings	-	-	x	Halifax
	ENTREPRENEURIAL MANAGEMENT LIMITED	x	x	x	Halifax
	French Road Explorations Limited	x	-	-	Halifax
	International Geochemical Associates Limited	x	x	x	Halifax
	Louisbourg Property Holdings	x	x	x	Halifax
	Whiteburn Precious Metals	x	x	x	Halifax
5.	GOLDEN CARIBOU EXPLORATIONS INC.	-	-	x	Caribou
	Lake Mine Resources	-	-	x	Caribou
	Golden Shadow Resources (formerly Pershon Gold Mines Limited)	-	x	x	Caribou
6.	M.E.X. EXPLORATIONS LIMITED	x	x	x	Truro
	CUVIER MINES INC. (including Preuvier Mines Ltd.)	x	x	x	Truro
	ACADIA MINERAL VENTURES LIMITED	x	x	x	Truro
	Americ Mines Limited	x	-	-	
	Atlantic Gold Mines Limited	x	-	-	
	Massval Resources Inc.	-	-	-	
7.	OUTLAND RESOURCES INC.	-	x	x	Country Harbour
	Acadian Gold Mines Limited	-	-	x	Country Harbour
	Bear Pass Resources Corp.	-	-	x	Country Harbour
8.	Blockhouse Resources Limited	x	x	x	Halifax
	Trafalgar Resource Investments	x	x	x	Halifax
9.	Northumberland Mines Limited	x	x	-	Sherbrooke
	GOLDENVILLE EXPLORATIONS	-	-	x	Sherbrooke
	Paragon Explorations Limited	x	-	-	
	PAN EAST RESOURCES INC.	x	x	x	Halifax
10.	SEABRIGHT RESOURCES INC.	x	x	x	Halifax

*Defined as companies dependent on senior sponsoring or risk capital (stock markets, etc.) for financing

Those in block letters are the principal operators in a group or have substantial or continual exploration programs.

Table 7. Statistics for the four largest categories of mineral exploration.

TIN AND TUNGSTEN EXPLORATION 1982					
CATEGORY	DOLLARS SPENT	PROJECTS	PROJECTS DRILLED	HOLES DRILLED	METRES DRILLED
MINING CO. (8)	1 397 575	19	3	57	5 932
EXPLORATION CO. (1)	51 850	1	1	17	1 166
PRIVATE (1)	1 800				
PROSPECTORS	NIL				
TOTAL: (10)	1 451 225	20	4	74	7 098
1981 COMPARISONS	(1 305 000)	(19)	(3)	(23)	(1 772)

Note: Revised December 15, 1983
Revised February 14, 1984

GOLD EXPLORATION 1982					
CATEGORY	DOLLARS SPENT	PROJECTS	PROJECTS DRILLED	HOLES DRILLED	METRES DRILLED
MINING CO. (7)	219 465	8	1	9	1 282
EXPLORATION CO. (6)	1 149 905	10	4	38	3 480
PRIVATE (12)	61 755	16	1	2	400
PROSPECTORS (29)	28 155 + 615 man days	32	1	4	470
TOTAL: (54)	1 484 885	66	7	53	5 632
1981 COMPARISONS	(2 026 784)		(10)	(86)	(9 661)

Note: Each man-day worked by unpaid prospectors is considered to be equivalent to $40.00 for the purpose of calculating the total value of exploration work.

Revised December 15, 1983.

Revised February 14, 1984

COAL AND METHANE EXPLORATION 1982					
CATEGORY	DOLLARS SPENT	PROJECTS	PROJECTS DRILLED	HOLES DRILLED	METRES DRILLED
MINING CO. (4)	1 128 880	4	2	3	1 199
EXPLORATION CO.	NIL				
PRIVATE	NIL				
PROSPECTORS	NIL				
GOVERNMENT (1)	312 200	2	2	58	3 959
TOTAL: (5)	1 441 080	6	4	61	5 158
1981 COMPARISONS	(2,464,731)	(7)	(6)	(82)	(12,012)

Revised: February 14, 1984

Table 7. Continued.

BASE METAL EXPLORATION 1982					
CATEGORY	DOLLARS SPENT	PROJECTS	PROJECTS DRILLED	HOLES DRILLED	METRES DRILLED
MINING CO. (7)	525 960	11	7	48	6 232
EXPLORATION CO. (2)	88 800	6			
PRIVATE (4)	45 850	4			
PROSPECTORS (3)	4 415 +100 man days	3			
TOTAL: (16)	669 025	24	7	48	6 232
1981 COMPARISONS	(2 203 525)	(41)	(12)	(127)	(14 551)

Revised: February 14, 1984

Note 1: Each man-day worked by unpaid prospectors is considered to be equivalent to $42.[illegible] for the purpose of calculating the total value of exploration work.

It may be noted that total exploration expenditures in 1982 were only 38 per cent of those experienced in 1981, and that the total amount of drilling was reduced to a similar level. The number of holes drilled did not decline as sharply, however, being at about 60 per cent of the previous year. Development expenditures are less easy to compare because large expenditures on few properties cause wide variations from one year to the next.

Exploration expenditures for most minerals were down from 1981, with the exception of tin and tungsten, which increased by 11 per cent, and barite which increased 63 per cent. Total drilling for tin and tungsten increased by 300 per cent over 1981.

Potash exploration decreased dramatically, and base metals exploration was substantially lower than 1981. Gold and coal were the only two commodities which did not decline by such a marked degree: gold remaining at 73 per cent and coal remaining at 84 per cent of 1981 levels.

INDUSTRIAL MINERALS

J. H. Fowler

Nova Scotia has been mining and exporting industrial minerals for over two hundred years. As an industrial mineral producer, this Province continues to rank as the number one gypsum mining and exporting region in North America. Mining of many other commodities is ongoing, supplying many local and export markets. Excluding aggregate producers, there are nineteen industrial mineral producers operating at thirty sites, producing nine commodities: anhydrite, barite, clay and shale, dolomite, gypsum, limestone, salt, silica sand, and stone (Fig. 1). Numerous aggregate producing operations supply all the Province's aggregate requirements and export some products to other regions of Atlantic Canada and as far away as Bermuda.

Throughout the year the outlook for industrial minerals improved. This is evident by the numerous requests for information on commodities such as aggregates, building stone, barite, celestite, clay, diatomaceous earth, gypsum, mineral fillers and extenders, salt deposits (for underground hydrocarbon storage purposes), silica sand, spodumene, wollastonite, and zeolites.

In 1982 exploration and development programs for barite, potash, gypsum, limestone, dolomite, silica sand, and granite amounted to expenditures of $2.4 million. Several of these programs have continued into 1983 and many new ones were initiated (Fig. 2).

BARITE

Exploration for barite in the Province continues at a high level because of its demand as a weighting agent used in offshore drilling programs.

Cuvier Mines Ltd. completed a barite drilling program at Pine Brook, Richmond County, and is drilling for base metals and barite near Walton, Hants County. Magcobar Dresser Canada have completed a diamond drilling and bulk sampling program on a barite property at Bass River, Colchester County. Indications are that Dresser will do more work on this property in 1984. Nystone Chemicals Limited completed a diamond drilling program on the Upper Brookfield deposit. Present plans for this property are to continue producing pharmaceutical grade $BaSO_4$ and begin the production of drill mud grade barite. Novex Mining and Exploration Company Limited began shipping drill mud grade barite from their mill at Enon, Cape Breton County. At Scoteville, Inverness County a bulk sample of barite has been selected by the licensee from the Campbell and MacInnis veins for drilling mud tests by National Mud Control Laboratories. Conwest undertook metallurgical and mine feasibility studies on their barite-fluorite property at East Lake Ainslie.

ANHYDRITE
1,11. Fundy Gypsum Co. Ltd.
2. Little Narrows Gypsum Co. Ltd

BARITE
3. Nystone Chemicals Ltd.
4. Novex Mining and Exploration Co. Ltd.
32. Magcobar Division, Dresser Canada Inc.

CLAY AND SHALE
5-8. L. E. Shaw Ltd.

DOLOMITE
9. Scotia Limestone Ltd.

GYPSUM
10-11. Fundy Gypsum Co. Ltd.
12. Domtar Construction Materials
13. National Gypsum Canada Ltd.
14. Georgia Pacific Corp. Bestwall Division
15. Little Narrows Gypsum Co. Ltd.
16. Canada Cement Lafarge Co. Ltd.

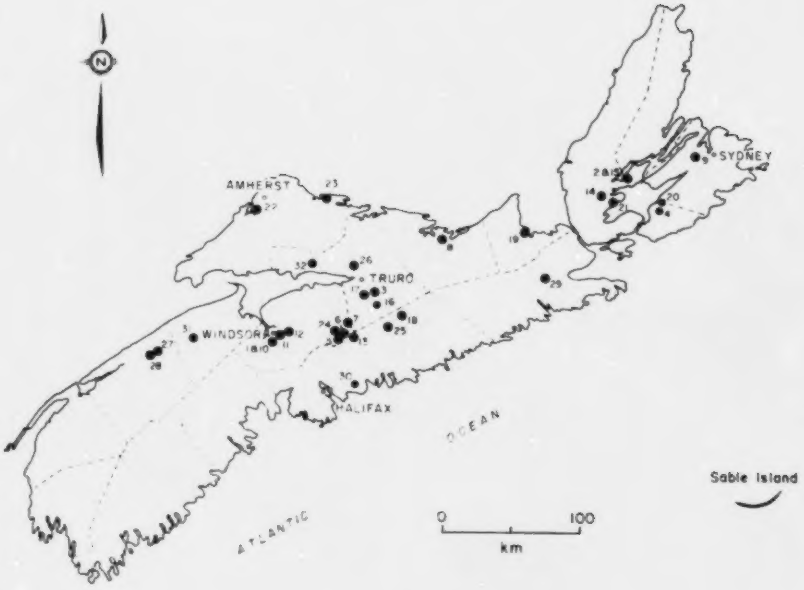
LIMESTONE
17. Canada Cement Lafarge Co. Ltd.
18. Mosher Limestone Co. Ltd.
19. Ridge Brokers Ltd.
20. Scotia Limestone Ltd.
21. Nova Scotia Sand and Gravel

SALT
22. Sifto Salt Division,
Domtar Chemicals Group
23. Canadian Salt Company ltd.

SILICA SAND
24-26. Nova Scotia Sand and Gravel

STONE
27. Heritage Memorials
28. A. & R. Nixon Granite Works Ltd.
29. Arsenault Monumental Works Ltd.
30. Norwood's Natural Stone

PEAT MOSS
31. Annapolis Valley Peat Moss Co.


N
AMHERST
TRURO
WINDSOR
HALIFAX
SYDNEY
ATLANTIC
OCEAN
Sable Island
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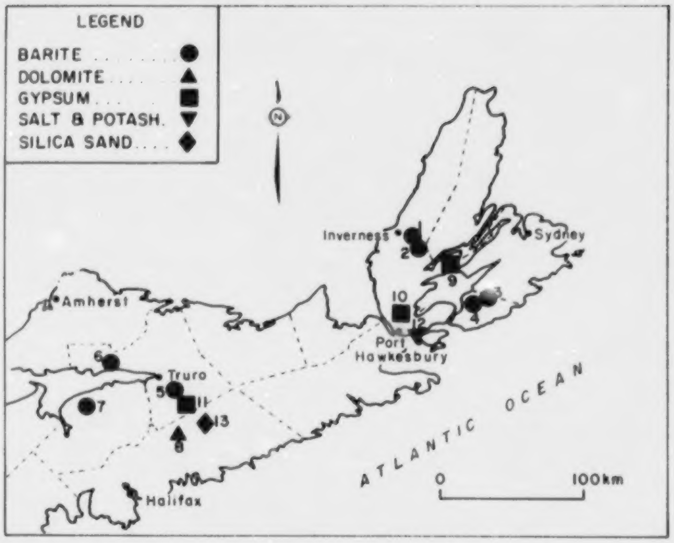
32

Figure 1. Industrial mineral producers in Nova Scotia.


LEGEND
BARITE ●
DOLOMITE ▲
GYPSUM ■
SALT & POTASH ▼
SILICA SAND ◆
N
Inverness
Sydney
Amherst
Truro
Port Hawkesbury
Halifax
ATLANTIC OCEAN
0
100km
1
2
3
4
5
6
7
8
9
10
11
12
13

Property	Activity
1. Scotsville Mineral Resources	bulk sampling and diamond drilling
2. Conwest	metallurgical testing and mine feasibility study
3. Novex Mining	production began in 1983
4. Cuvier Mines	diamond drilling program
5. Nystone	diamond drilling and bulk sample testing
6. Magcobar Canada	bulk sampling and diamond drilling
7. Cuvier Mines	diamond drilling
8. Mosher Limestone	development program
9. Little Narrows Gypsum	reserve development
10. Georgia Pacific	new quarry development
11. Canada Cement	new quarry production
12. Gulf Canada	made application for salt and potash exploration licence and underground gas storage permit
13. Nova Scotia Sand and Gravel	diamond drilling program

Figure 2. Recent industrial mineral exploration and development programs underway in Nova Scotia.

CLAY AND SILICA SAND

Deposits of interstratified clay, silica sand and lignite, exceeding 125 m in thickness, of Cretaceous age are well known in several regions of the Province. Small scale mining for clay and silica sand is continuing at Shubenacadie and West Indian Road, and intermittent mining has occurred at Elmsvale and Upper Stewiacke. The Shubenacadie clay is used for the manufacture of structural clay products and the silica sand is used as an industrial sand and in manufacturing fibreglass insulation.

This year the Department of Mines and Energy carried out a two part program consisting of refraction seismic surveys and diamond drilling to locate additional deposits (Fig. 3). Most of the thirty-seven seismic profiles were done at the margins of the Windsor basin (Fig. 4). This technique was useful in locating areas of extreme depth to bedrock conditions where Cretaceous sediments may have endured. Several interesting profiles were produced, many of which have been drilled, and the results of the program are presently being evaluated.

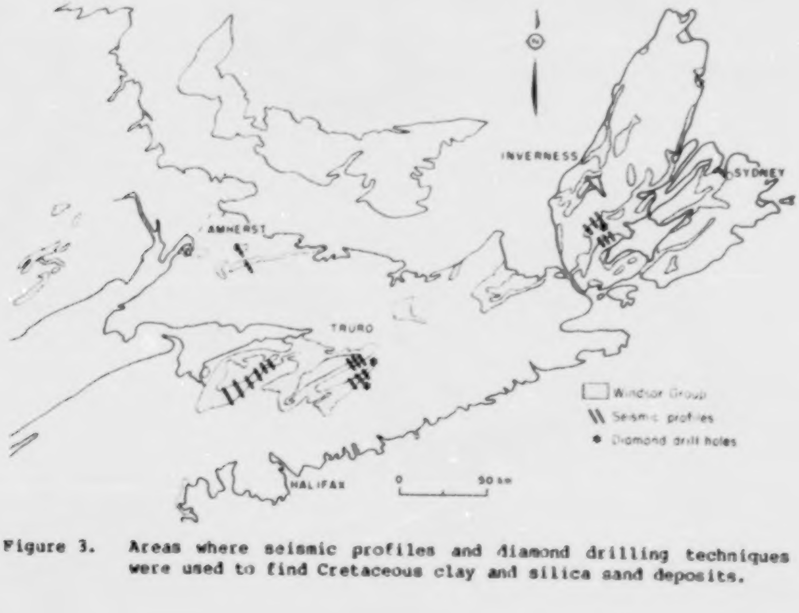


Figure 3. Areas where seismic profiles and diamond drilling techniques were used to find Cretaceous clay and silica sand deposits.

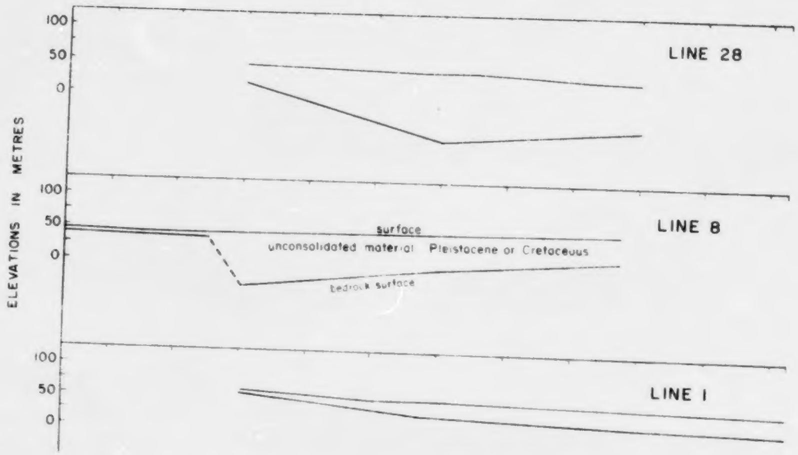


Figure 4. Examples of refractive seismic profiles produced during the Cretaceous deposits exploration program.

DOLOMITE

Mosher Limestone continued with development work on a dolomite deposit for agricultural purposes at Cooks Brook, Halifax County.

GYPSUM

Georgia Pacific began a development drilling program on their gypsum deposit at Sugar Camp, Inverness County, and Canada Cement has opened a small gypsum quarry at Upper Brookfield, Colchester County. At Little Narrows, Victoria County, Little Narrows Gypsum continued with mine development work on reserves adjacent to their operating quarry.

LIMESTONE

In 1983, preliminary work was completed on samples from several of the Province's limestone and dolomite deposits for SO_2 sorbent utilization tests in fluidized bed combustion of coal. Samples were collected by Nova Scotia Department of Mines and Energy, and the analytical work done by Canmet in Ottawa.

SALT AND POTASH

Noranda Exploration continues to hold their special licence for potash exploration in the Ashfield, Inverness County area. Dow Chemical holds salt and potash development licences at Lower River Inhabitants and Port Richmond, Richmond County. Dow also holds an underground gas storage licence in the same area. Domtar continues to hold their salt development licences at Kingsville, Inverness County and St. Peters, Richmond County.

Gulf Canada Ltd. recently applied for a salt and potash exploration licence and an underground gas storage permit in the McIntyre Lake area of Inverness County.

SILICA SAND

Nova Scotia Sand and Gravel completed exploration and diamond drilling programs for silica sand at MacPhees Corner, Hants County, and Elmsvale, Halifax County.

AGGREGATE RESOURCES

W. J. Wright

AGGREGATE RESOURCES OF SOUTHWESTERN NOVA SCOTIA

The 1983 field season completed a program begun in 1982 to identify all granular and bedrock aggregate resources in southwestern Nova Scotia. This survey should provide information on the location, quality and quantity of extractable materials, and the identification of bedrock sites suitable for aggregate quarry operations.

The 1983 study area covers the Counties of Shelburne and Yarmouth (Fig. 1) and includes all or parts of the following 1:50 000 national topographic map sheets: 20O/09, 20O/16, 20P/05, 20P/06, 20P/11, 20P/12, 20P/13, 20P/14, 20P/15, 21A/03, 21A/04, and 21B/01.

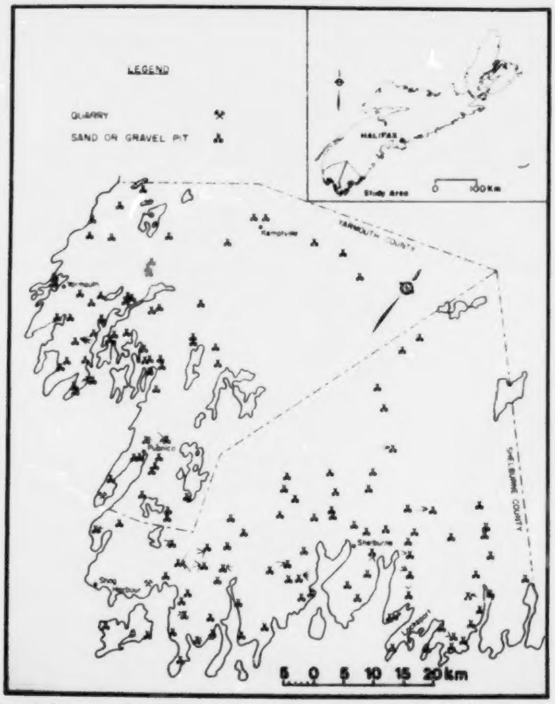

LEGEND
QUARRY
SAND OR GRAVEL PIT
HALIFAX
Study Area
0
100Km
Kemptville
YARMOUTH COUNTY
Yarmouth
Pubnico
Shelburne
SHELBURNE COUNTY
Shag Harbour
5 0 5 10 15 20km

Figure 1. Locations of aggregate pits and quarries in Yarmouth and Shelburne Counties.

The glaciofluvial and bulk bedrock samples collected will undergo a series of tests that could include most of the following: soundness loss (ASTM C88), Los Angeles abrasion loss (ASTM C131), grading analysis, petrographic analysis (DOT N.S. Method), and organic content (ASTM C40). Test results will indicate which deposits contain aggregates suitable for the production of hot-mix asphalt and/or Portland Cement concrete.

In addition to the bulk samples, interesting or mineralized rock samples were collected, and fines were panned from many deposits. These samples will be retained for possible future analyses.

Resistivity or seismic geophysical work may be attempted at a later date to aid in the assessment of selected deposits.

Field information has been plotted on 1:50 000 scale national topographic map sheets, and the final product will consist of 1:100 000 scale maps with a report.

Throughout the study area sand and gravel and quarry sites have been recorded and appear to be fairly well distributed (Fig. 1). In both counties, the large aggregate operations are established primarily in ice-contact deposits, whereas the smaller, seasonal operations tend to work in all types of surfical materials.

At present, most aggregate demands in Shelburne and Yarmouth Counties are being satisfied, and the reserves appear adequate for the near future.

Increases in aggregate consumption are anticipated during the next few years because of the development of a new tin mine, construction of a new provincial highway system, and a program of wharf reconstruction and protection.

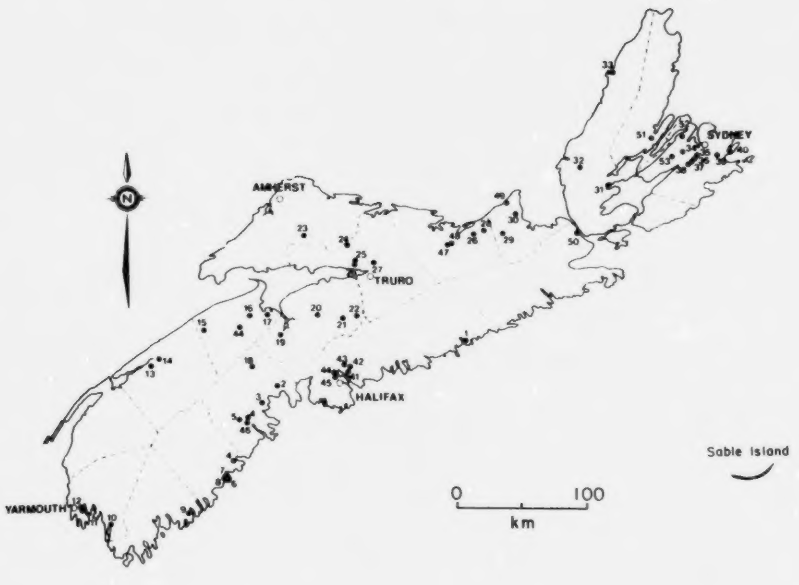
STRUCTURAL MATERIAL PRODUCERS

In 1979, the Nova Scotia Department of Mines and Energy began recording the locations (Fig. 2) and reporting the annual statistics on most aggregate producers in Nova Scotia.

Monitoring the growth and activities of the provincial aggregate industry is necessary because of the industries importance to the Nova Scotia economy. Although aggregate production levels have fluctuated over the past four years the value of production has increased from $28 million dollars in 1979 to $36 million dollars in 1982 (Table 1). In 1982, aggre-

Table 1. Value and quantity of aggregate (crushed stone; sand and gravel) produced in Nova Scotia, 1979-1982.

	1979	**1980**	**1981**	**1982**
Value ($1000's)	27 836	28 814	34 417	36 244
Quantity (1000's tonnes)	10 811	10 275	11 165	8 521



Sand and Gravel

1. Blois V. Smith Ltd.
2. South Shore Sand and Gravel Ltd.
3. Clearland Enterprises Ltd.
4. Acadia Road Contractors Ltd.
5. Naugler Construction Ltd.
6. Everette J. Hanley Construction Ltd.
7. Mosher and Rawding Ltd.
8. Budget Paving Ltd.
9. Allister Harlow Construction Ltd.
10. Amiro and Surette Trucking & Excavating Ltd.
11. Yarmouth Concrete & Gravel Ltd.
12. Aberdeen Paving Ltd.
13. Canadian Pacific Railway
14. Clyde Everett (1972) Ltd.
15. Roy Hiltz Contracting Ltd.
16. Maurices Ready-Mix Ltd.
17. W. K. Sharpe and Son Contracting Ltd.
18. Sidney C. Hiltz Dozing and Trucking Ltd.
19. Vernon H. Shaw
20. Dexter Construction Ltd.
21. L & M Gallant Contracting, Trucking Ltd.
22. Nova Scotia Sand and Gravel Ltd.
23. Cumberland Paving and Contracting Ltd.
24. Permanent Concrete Ltd.
25. Latimer Construction Ltd.
26. Warren Maritimes Ltd.
27. Will-Kare Paving and Contracting Ltd.
28. Inter-supply Ltd.
29. Carson Enterprises Ltd.
30. Kell Interprises Ltd.
31. Construction Aggregates Ltd.
32. Zutphen Brothers Construction Co. Ltd
33. Chiasson Brothers Ltd
34. Martell's Construction Ltd.
35. Malcolm S. MacDonald Co. Ltd.
36. Municipal Ready-Mix Ltd.
37. Meadows Sand and Gravel Ltd.
38. Doug Burns Excavating & Contracting Ltd.
39. G. and M. Sweeney Construction Ltd.
40. H. W. Phillips Construction Ltd.

Crushed Stone

41. W. Eric Whebby Ltd.
42. Conrad Brothers Ltd.
43. Rocky Lake Quarry Ltd.
44. Standard Paving Maritimes Ltd.
45. Gateway Materials Ltd.
46. Nauss Brothers Ltd.
47. Satellite Construction Co. Ltd.
48. S. W. Weeks Construction Ltd.
49. Colin R. MacDonald Ltd.
50. Construction Aggregates ltd.
51. Gillis Construction Ltd.
52. LaVatte Construction Co. Ltd.
53. Scotia Limestone Ltd.

Figure 2. Locations of aggregate producers in Nova Scotia.

gates exceeded other important industrial minerals such as salt and gypsum both in tonnes produced and in dollar value of production.

The Department also collects and records information on concrete product and ready-mix manufacturers, and silica sand, shale, and clay producers in the Province.

DRILL CORE LIBRARY

J. M. Bingley

The Department of Mines and Energy (Fig. 1) now maintains core storage facilities at four locations in a total of six buildings. Previous to 1983, core was stored at the office-garage complex on Bridge Avenue in Stellarton and in a converted ammunition bunker in the Debert Air Industrial Park. Additional facilities that came on stream in late 1982 and early 1983 are the former Chevron-Irving core building at Malagawatch, Inverness County and three new structures in the Stellarton Industrial Park. Total storage capacity is now approximately 380 000 m.

Approximately 124 721 m of new core was acquired in 1982-83 (Table 1), and large quantities continue to come in. When the present backlog is stored and manpower becomes available, we will publish a catalogue of all core in storage.

Since facilities are not manned on a full-time basis, anyone wishing to examine drill core should arrange for a date well in advance (call 752-8429).

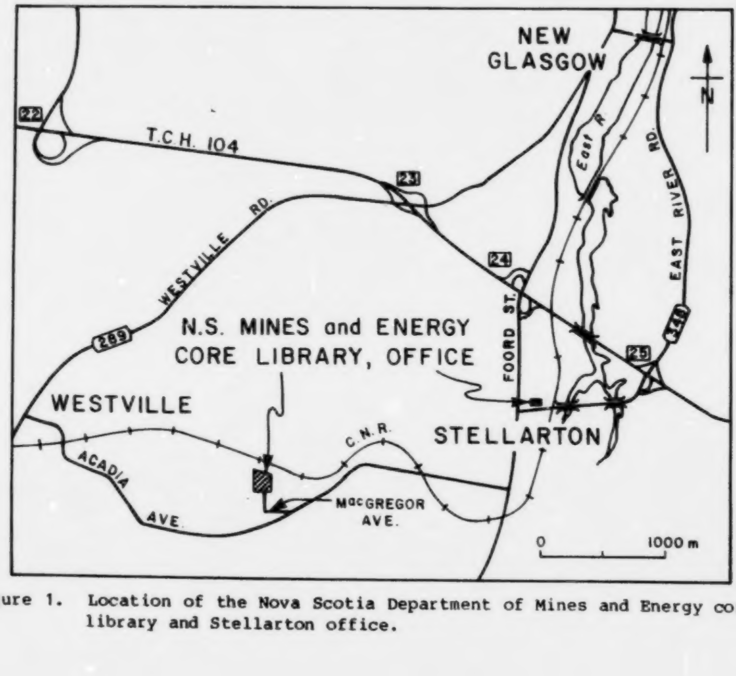

NEW
GLASGOW
N
22
T.C.H. 104
23
WESTVILLE RD.
East R.
EAST RIVER RD.
24
FOORD ST.
289
348
25
N.S. MINES and ENERGY
CORE LIBRARY, OFFICE
WESTVILLE
C.N.R.
STELLARTON
ACADIA AVE.
MacGREGOR AVE.
0
1000 m

Figure 1. Location of the Nova Scotia Department of Mines and Energy core library and Stellarton office.

Table 1. Drill core acquisitions in Departmental core libraries for 1982-83 (to October 1, 1983)

STELLARTON CORE LIBRARY

Company or Group	**Location of Drilling**	**Amount (m)**
Coal Inventory Program	Sydney Mines, Cape Breton County	1 094
	Springhill, Cumberland County	2 697
Carboniferous Stratigraphy Program	Sydney, Cape Breton County	1 013
Saarberg Interplan Can. Ltd.	Hants County	10 363
E & B Explorations Ltd.	New Ross, Lunenburg County	1 694
Yava Mines (Phelps-Dodge)	Salmon River, Cape Breton County	3 619
Gulf Minerals Canada Ltd.	Cobequid Mtns., Colchester County	12 192
	Cumberland Basin, Cumberland County	4 877
	Walton, Hants County	3 658
Cominco et al.	Sterling, Richmond County	1 524
Shell Canada Resources Ltd.	South Mountain, Kings, Digby, Annapolis Counties	11 339
Noranda Explorations Ltd.	Tatamagouche, Colchester County	8 120
Amax	Jubilee, Victoria County	8 230
Domtar/Sifto Salt Div.	Nappan, Cumberland County Kingsville, Inverness County St. Peters, Richmond County	10 363
Lacana Mining Corporation	River John, Pictou County	2 159
Kaiser Celestite	Lake Enon, Cape Breton County	14 857
Noval Technologies	New Glasgow, Pictou County	866
Suncor-Brinco Joint Venture	Stellarton, Pictou County	3 139
Granges Exploration AB	Smithfield, Colchester County	2 079
Nova Scotia Department of Mines and Energy (coal inventory)	Stellarton, Pictou County	1 108
Nova Scotia Department of Mines and Energy (gold project)	Holland Harbour, Guysborough County	498
Nova Scotia Department of Mines and Energy (Carboniferous strat. project)	Glen Road, Antigonish County	847
Louisbourg Property Holdings et al.	Gabarus Bay area, Cape Breton County	5 412
Esso Minerals	Cumberland Basin, Cumberland County	1 195
J. Leslie	St. Peters area, Richmond County	202
Sullivan Mining Group Ltd.	Tangier, Halifax County	317
Blockhouse Resources Ltd.	Blockhouse, Lunenburg County	634

MALAGAWATCH CORE LIBRARY

Chevron-Irving Joint Venture	Malagawatch, Inverness County	10 625
	TOTAL	**124 721**

MINERAL INVENTORY*

H. A. Lyttle

GEOSCAN BIBLIOGRAPHIC ACTIVITIES

Indexing and on-line data entry of bibliographic information into GEOSCAN, the national database for bibliographic geological information, continued throughout 1983. Document types entered into GEOSCAN were assessment reports, open file reports, publications, geoscience theses and journal literature. *Report 83-2, Index to Assessment Reports 1982 (with Keyword Index)* was released in June 1983. An Index to 1983 Assessment Reports and an Index to Publications and Open File Reports for 1981, 1982 and 1983 are presently under preparation, and should be released early in 1984. To date, GEOSCAN contains the following Nova Scotia Department of Mines and Energy records: 3000 assessment reports; 900 publications; 510 open file reports; 290 theses; and 280 journal literature references.

INDEX TO GEOSCIENCE MAPS OF NOVA SCOTIA

This index, now under preparation, will list all the known geoscience maps in NSDME GEOSCAN records. The index will be organized on the basis of NTS map sheets, and within any one map sheet, map information will be listed under five data fields, namely: general map type; specific map type; map scale; year of publication; and source of map. The example below is a partial listing for map sheets 11D/12 and 11F/14C.

MAP SHEET	GENERAL MAP	SPECIFIC MAP	MAP SCALE	YEAR	SOURCE	
11D/12	GEOCHEMICAL	WELL WATER GEOCHEMICAL	1:4 800	1982	NSOFR	571
	GEOLOGICA	GEOLOGICAL	NO SCALE	1982	NSOFR	571
		ISOPACHS	1:4 800	1982	NSOFR	571
		LINEAMENTS	1:633 600	1982	NSOFR	571
		MARINE SEDIMENT TYPE	1:126 720	1964	NSTHESIS	018
11F/14C	GEOCHEMICAL	SOIL GEOCHEMICAL	1:2 500	1980	NSMAR	11F/14D 07-J-87(01)
		STREAM SEDIMENT GEOCHEMICAL	1:10 000	1980	NSMAR	11F/14D 07-J-87(01)
	GEOLOGICAL	GEOLOGICAL	1:10 000	1980	NSMAR	11F/14D 07-J-87(01)
	LOCATION	PROPERTY LOCATION	1:3 500 000	1980	NSMAR	11F/14D 07-J-87(01)
		ROCK SAMPLE LOCATION	1:10 000	1980	NSMAR	11F/14D 07-J-87(01)
		STREAM SEDIMENT SAMPLE LOCATION	1:10 000	1980	NSMAR	11F/14D 07-J-87(01)

INDEX TO GOLD INFORMATION ON NOVA SCOTIA

Information on gold in Nova Scotia from all known and available sources is presently being compiled, and a bibliographic index to gold information on Nova Scotia will eventually be published. The index will consist of two sections: a complete listing by author of all the compiled references; and a listing by individual gold district. The gold district listing will consist of both an author listing and an available map type listing.

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*Contribution to Canada-Nova Scotia Co-operative Mineral Program, 1981-84. Project carried by Nova Scotia Department of Mines and Energy and by Geological Survey of Canada.

GEOSCIENCE THESES AND JOURNAL LITERATURE PROJECT

This project, in its second year of EMR funding under the Canada-Nova Scotia Co-operative Mineral Agreement, has created a public microfilm file of 430 geoscience theses (B.Sc., M.Sc. and Ph.D.) on Nova Scotia, available up to 1980. A bibliographic index to these theses, by author and map sheet, was published in *Report 81-6, Index to Publications, Open File Reports and Theses 1862-1980*. To date, 190 theses have been fully indexed and entered into GEOSCAN. It is anticipated that by mid-1984 all 430 theses will be in GEOSCAN, and a keyword index will be available. A thesis study area map is also under preparation and should be available by mid-1984.

METALLIC MINERAL OCCURRENCES PROJECT

The project, in its second year of EMR funding under the Canada-Nova Scotia Co-operative Mineral Agreement, involves the checking and updating of the metallic mineral occurrences data (MOD) card file. All the existing 800 metallic MOD cards have been checked and updated, the metallic mineral occurrences lists revised, and the metallic mineral occurrences maps (OFR 454) also revised. At present, post-1977 assessment reports, open file reports and publications cited in *Reports 81-4* and *81-6* are being searched for new mineral occurrences information. To date, these document searches have been completed to the end of 1980, resulting in an additional 386 updates to existing MOD cards, and the creation of 10 new metallic MOD cards.

DRILLHOLE DATA BASE PROJECT

This project, funded by EMR during 1983 as part of the Canada-Nova Scotia Co-operative Mineral Agreement, has resulted in the development of a computerized drillhole data base. The database consists of 28 fields, containing information such as map sheet, latitude, longitude, mineralization, assay, etc., on individual holes drilled in Nova Scotia, largely for the purpose of onland mineral exploration. The data base can be searched on any one field, or combination of fields, and the results printed out at a computer terminal. In addition, computer-generated maps of drillhole locations, at various scales, can be plotted on a drum plotter. To date, coding and data entry have been completed for all drillholes in assessment reports cited in *Report 81-7, Index to Drillhole and Well Data 1862-1980*, covering map sheets 11D, 11E, 11F and 11K. This coverage represents 470 assessment reports, containing 6000 drillholes.

ASSESSMENT REPORTS AND OPEN FILE REPORTS FOR 1983

By the end of 1983, an additional 188 assessment reports and 35 open file reports became available. Lists of these reports are published as Appendices I and II in this Report of Activities. All these reports have been microfilmed and can be consulted in the libraries of the Halifax and Stellarton offices of the Department. Microfiche copies of these reports can also be purchased directly from Precision Microfilming Services, 6100 Young Street, Halifax, Nova Scotia, B3K 2A4 (902-455-5451).

SYDNEY BASIN PROJECT-AN UPDATE*

R. C. Boehner

Geological studies of Carboniferous rocks in the Sydney Basin, Glengarry Half Graben, and Loch Lomond Basin, Cape Breton Island, continued in 1983 as part of the Canada-Nova Scotia Co-operative Mineral Program (CNSCMP). Stratigraphic and structural studies were completed in the area east of the Coxheath Hills, Sydney Harbour to Mira Bay, and south to East Bay Block and the Mira River (Fig. 1). Concurrently, Garth Prime completed detailed investigation of the sedimentology, stratigraphy, and structure of the Glengarry Half Graben (Prime and Boehner, this volume). Selected

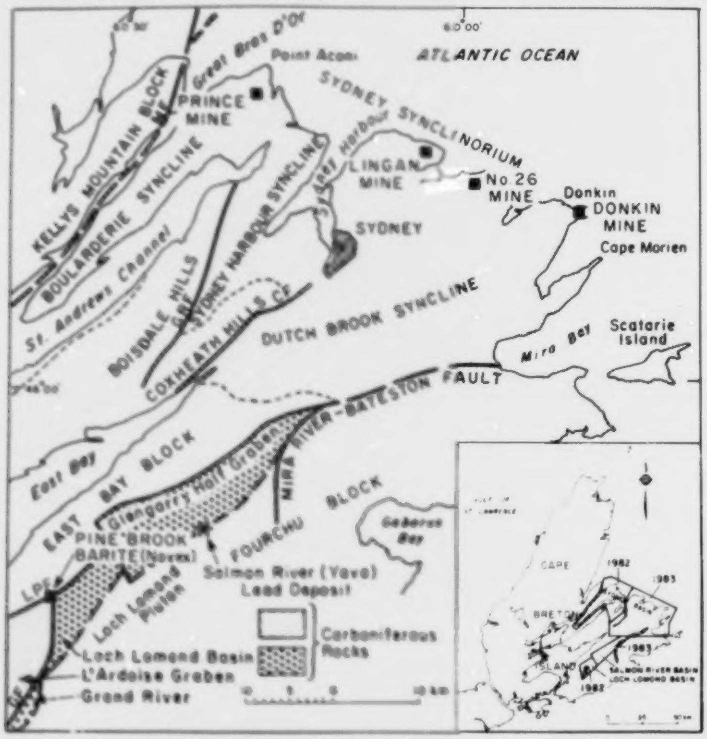
60°00'
ATLANTIC OCEAN
Point Aconi
Great Bras D'Or
PRINCE MINE
KELLYS MOUNTAIN BLOCK
BOULARDERIE SYNCLINE
SYDNEY SYNCLINORIUM
Sydney Harbour
SYDNEY HARBOUR SYNCLINE
LINGAN MINE
No. 26 MINE
Donkin
DONKIN MINE
Cape Morien
SYDNEY
St. Andrews Channel
BOISDALE HILLS
COXHEATH HILLS
DUTCH BROOK SYNCLINE
Mira Bay
Scatarie Island
MIRA RIVER-BATESTON FAULT
East Bay
EAST BAY BLOCK
Glengarry Half Graben
MIRA RIVER
FOURCHU BLOCK
Gabarus Bay
PINE BROOK BARITE (Norex)
Salmon River (Yava) Lead Deposit
LPF
Loch Lomond Pluton
Loch Lomond Basin
L'Ardoise Graben
Grand River
Carboniferous Rocks
10 5 0 10 km
CAPE BRETON ISLAND
1982
1983
SALMON RIVER BASIN
LOCH LOMOND BASIN

Figure 1. Location map, Sydney Basin Project area, eastern Cape Breton Island, Nova Scotia. Faults: Grand River (GF), Lennox Passage (LPF), Coxheath (CF), George River (GRF), Mountain (MF).

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*Contribution to Canada-Nova Scotia Co-operative Mineral Program 1981-84. Project caried by Nova Scotia Department of Mines and Energy and by Geological Survey of Canada.

sections of the Morien Group were studied in detail by Dr. Brian Rust of the University of Ottawa and Dr. Martin Gibling of Dalhousie University (this volume) and by Margaret Best of the University of Ottawa (this volume).

Complementary and independent geological studies were conducted by Pierre Vaillancourt and Dr. Don Sangster of the Geological Survey of Canada on sediment hosted base metal deposits in the Glengarry Half Graben, and by David McMullin and Dr. Sandra Barr of Acadia University on the geology of the Loch Lomond and Irish Cove plutons. These plutons are situated in pre-Carboniferous terrane north and south of the Glengarry Half Graben.

This research, supplemented by basin analysis using the entire Carboniferous succession, should permit significant advances in the geological understanding and interrelationships of the Sydney, Glengarry, and Loch Lomond areas. Results from previous Sydney Basin project activities are included in reports by Giles (1983), Dilles and Rust (1983), Rust et al. (1983), and Boehner (1983).

GENERAL GEOLOGY

The large coal resources and long history of coal mining in the Sydney Basin have led to a large volume of previous geological work. Much of this work has concentrated on the Sydney coalfield, situated along the coastal and offshore areas. Descriptions of the geology, biostratigraphy, paleontology and coal geology are included in maps and reports (and contained references) by Bell (1938), Duff et al. (1982), Forgeron (1980), Hacquebard (1983), and Zodrow and McCandlish (1980).

The Sydney, Glengarry, and Loch Lomond structural basins are situated in eastern Cape Breton Island (Fig. 1) and are bounded on one or more sides by major faults and pre-Carboniferous basement rocks in the Kellys Mountain, East Bay and Fourchu Blocks (Fig. 2). The major structures in the basins have a pronounced northeasterly trend with the larger Sydney Basin (synclinorium) containing three major synclines with intervening arches formed by pre-Carboniferous rocks of the Coxheath and Boisdale Hills. The Glengarry and Loch Lomond Basins in contrast are relatively simple half graben basins with a common northwest border fault. All three structural basins appear to represent parts of formerly more extensive basins that have been dislocated by faulting.

The stratigraphic successions within the Sydney Basin and the Glengarry Half Graben-Loch Lomond Basin (Fig. 3) range in age from Early to Late Carboniferous, but are distinctly different in most respects, particularly in the Late Carboniferous. The two principal differences (ignoring thickness and minor facies variations) are: (1) the absence of recognizable Early Carboniferous Horton Group and the earliest Windsor Group in the Loch Lomond and Glengarry area; and, (2) the presence of major hiatus (regional unconformity) in the early part of the Late Carboniferous in the Sydney Basin (Fig. 3). These two features are important in interpreting the paleogeographic and depositional histories of these two areas, which are now in close proximity, but have distinctive stratigraphic records.

STRATIGRAPHY

The general stratigraphic succession of the Carboniferous rocks in the western part of the Sydney Basin, outlined by Giles (1983), has been recognized in the eastern part of the Basin (Figs. 2 and 3) with the following modifications: (1) an unnamed redbed unit is present above the upper (fine) Morien Group in the offshore parts of the Basin, and (2) a red calcareous (pedogenic) facies occurs in the Morien Group in the Wadden Cove area on Mira Bay. All map units (Fig. 2) will be defined as formal lithostratigraphic units in the final maps and report on the area (in preparation). A series of three generalized cross-sections (Fig. 2) has been constructed to illustrate the general structural situation.

The oldest Carboniferous rocks in the Sydney Basin are coarse, alluvial-fanglomerate deposits of the Grantmire Formation (revised by Giles, 1983) locally greater than 800 m in thickness. These rocks are onlapped and overlain by the Windsor Group comprising interstratified fine to coarse continental clastics, marine carbonates and evaporites. The Windsor Group has a total thickness exceeding 550 m.

The presence of the Grantmire Formation has not been confirmed in the Loch Lomond Basin-Glengarry Half Graben. In this area, the upper part of the Lower Windsor and the Upper Windsor overstep and onlap directly upon pre-Carboniferous basement (Boehner, 1981, 1983) without intervening Grantmire. The Windsor Group in the Loch Lomond Basin-Glengarry Half Graben has a maximum thickness of 300+ m.

The base of the Windsor Group in the Sydney Basin is marked by a basal carbonate ranging in thickness from 3 to 15+ m. Thick shelly bank facies are locally developed in areas of onlap onto basement, such as at Youngs Point, Scotch Lake and also onto Grantmire Formation at Glen Morrison (Figs. 2 and 3). This facies is the Gays River Formation of Giles et al. (1979). The more areally extensive facies, however, is the Macumber Formation laminate which is well developed on Grantmire Formation on the northern and southern sides of the Coxheath Hills. A third facies in the basal carbonate is the Gays River Formation interbank facies (Giles et al., 1979) comprising very argillaceous to silty dark grey limestone with scattered shells. It occurs down dip from banks in the Glen Morrison area.

The basal carbonate in the Sydney Basin is overlain by a complex sequence comprising up to 150 m of interstratified siliciclastic and gypsum-anhydrite rocks similar to the Meaghers Grant and Carrolls Corner Formations of Giles and Boehner (1979). With the possible exception of basal conglomerate of uncertain assignment (Fig. 3), there is no known equivalent to this basal Windsor succession in the Loch Lomond Basin-Glengarry Half Garben.

In the Sydney Basin, this sequence is overlain by up to 150 m of interbedded fine to coarse siliciclastics, gypsum, anhydrite and fossiliferous marine carbonate rocks typical of the upper part of the Lower Windsor. Coarse conglomerates are locally well developed, particularly around the perimeter of the Coxheath Hills. The lithologically similar Loch Lomond and Enon Formations are the combined correlatives in the Loch Lomond Basin-Glengarry Half Graben and have an aggregate thickness of 140+ m.

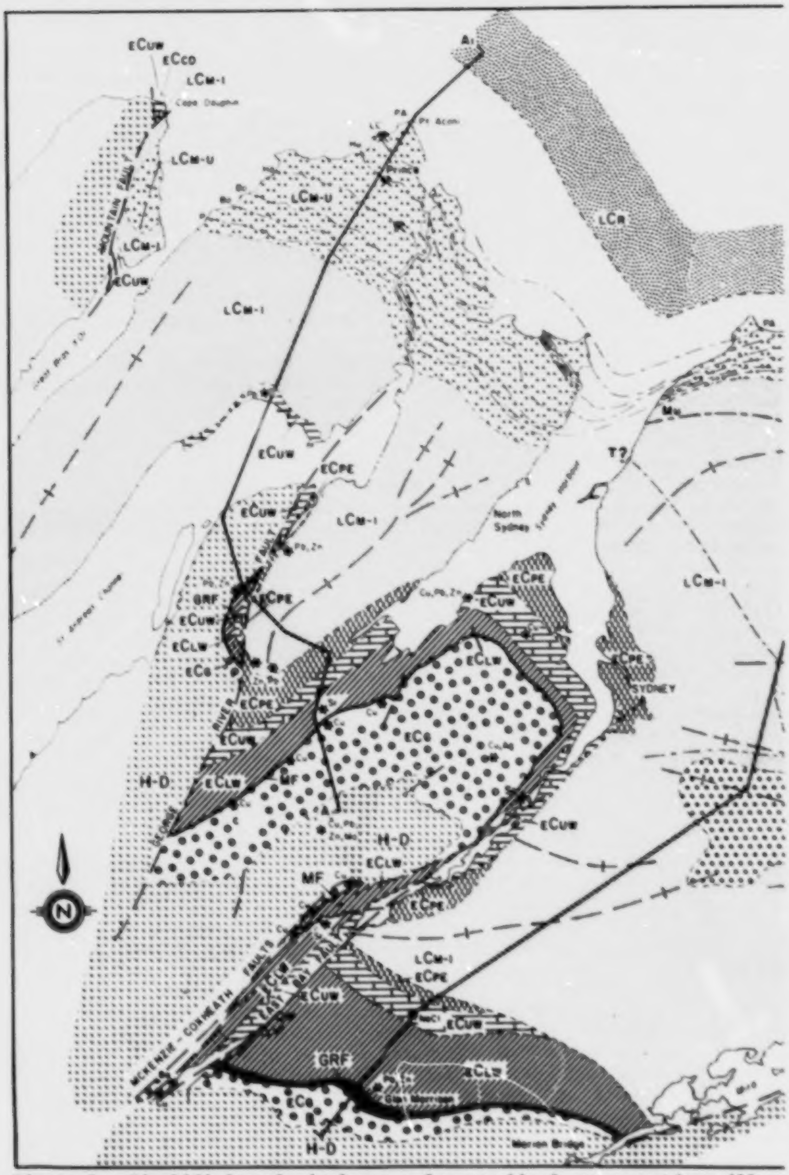
ECUW
ECCD
LCM-I
Cape Dauphin
A1
PA
LC
Pt Aconi
Princess
LCM-U
LCM-U
MOUNTAIN FAULT
LCM-I
ECUW
LCR
LCM-I
Great Bras d'Or
ECUW
ECPE
ECUW
LCM-I
Pb, Zn
North Sydney
Sydney Harbour
T?
Mu
PA
St Andrews Channel
Pb, Zn
GRF
ECPE
ECUW
ECLW
ECG
Cu, Pb, Zn
ECPE
ECUW
ECLW
ECPE
SYDNEY
LCM-I
RIVER
ECPE
ECUW
Cu
ECG
Cu, Ag
H-D
ECLW
MF
Cu
GEORGE
Cu, Pb
Zn, Mo
H-D
ECUW
ECLW
MF
ECPE
N
MCKENZIE - CONWEATH FAULTS
ECLW
EAST BAY
LCM-I
ECPE
ECUW
ECUW
GRF
ECLW
Glen Morrison
ECG
H-D
Marion Bridge

Figure 2. Simplified geological map and generalized cross-sections illustrating structure of the Sydney Basin, Cape Breton Island, Nova Scotia.

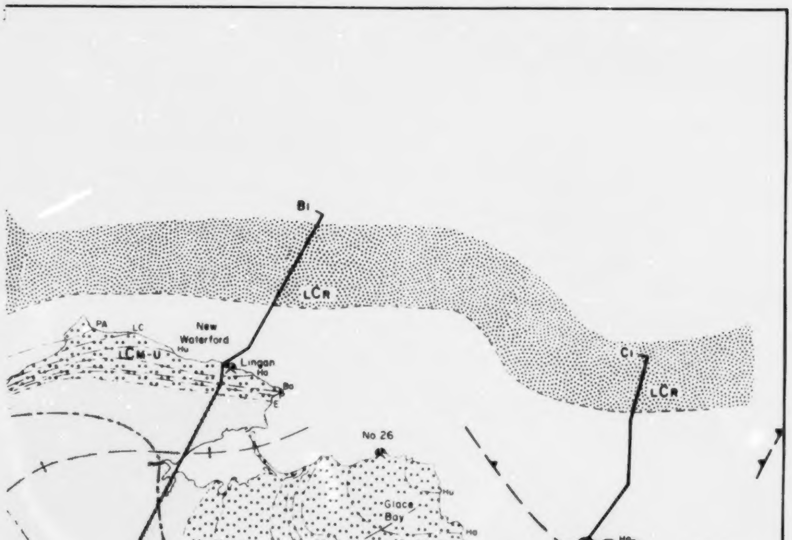
B1
LCR
PA
LC
New Waterford
LCM-U
Hu
Lingan
Ha
Bo
E
No 26
Glace Bay
Hu
Ha
Bo
Bo
E
C1
LCR
Ha
Bo
Donkin
LCM-I
LCM-U
LCM-r
LCM-I
Port Morien
LCM-U
LCM-r
LCM-U
LCM-I
Atlantic Ocean
Mira Bay
MIRA RIVER FAULT
BATESTON FAULT
Mira River
H-D
LCM
ECUW
Zn, Pb
C
Ba
H-D
0
4
8km

Figure 2. Continued.

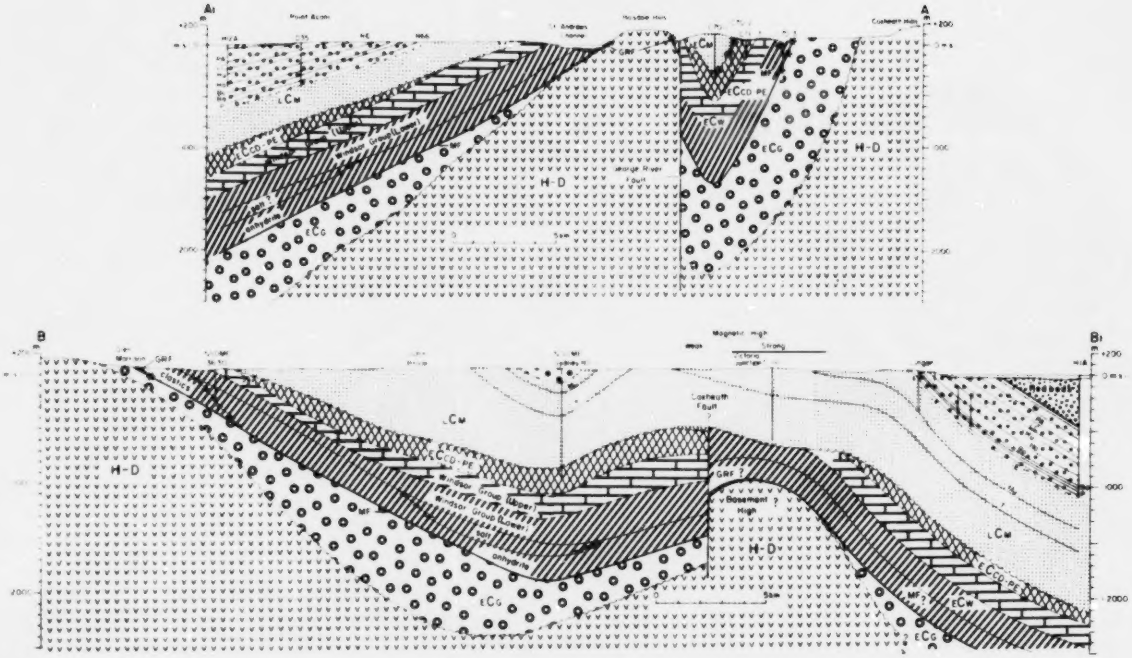
A1
Point Aconi
LCM
ECCD-PE
Windsor Group (Lower)
anhydrite
ECG
St. Andrews Channel
Boisdale Hills
GRF
H-D
George River Fault
ECM
ECCD PE
ECW
ECG
H-D
Coxheath Hills
A
+200
2000
0
5km
B
GRF
clastics
H-D
LCM
ECCD-PE
Windsor Group (Upper)
Windsor Group (Lower)
salt
anhydrite
MF
ECG
Magnetic High
Weak
Strong
Coxheath Fault
?
GRF ?
Basement ?
High
H-D
MF ?
ECW
ECCD-PE
LCM
Red beds
ECG
B1
+200
0 m s
1000
2000
0
5km

Figure 2. Continued.

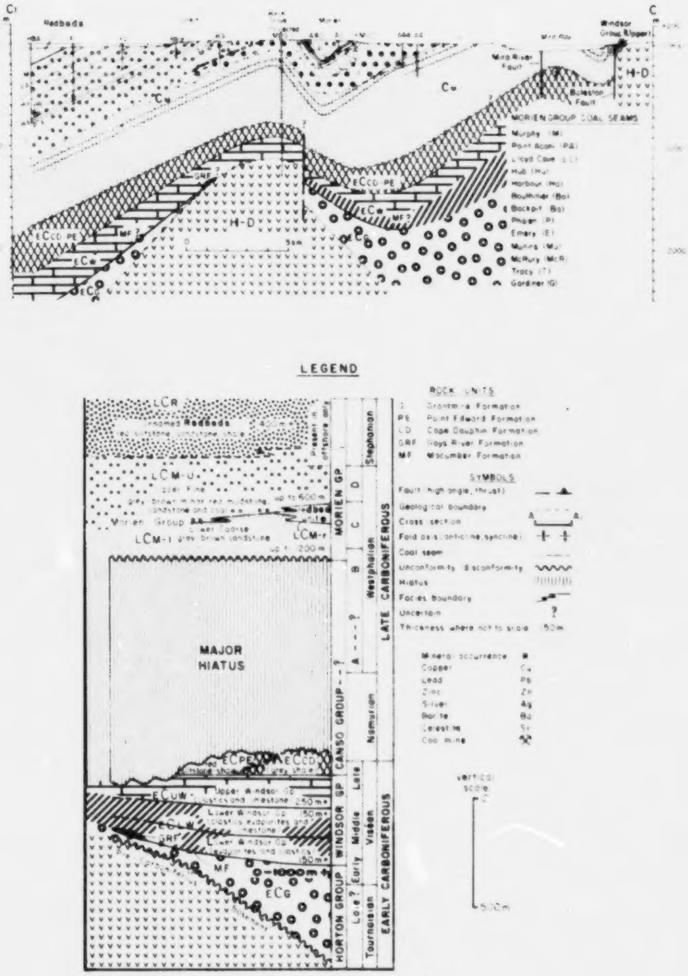
C1
C
Redbeds
Mira River Fault
Windsor Group (Upper)
Bateston Fault
H-D
Cu
ECcd PE
GRF
MF?
ECw
ECg
MORIEN GROUP COAL SEAMS
Murphy (M)
Point Aconi (PA)
Lloyd Cove (LC)
Hub (Hu)
Harbour (Ha)
Bouthillier (Bo)
Backpit (Ba)
Phalen (P)
Emery (E)
Mullins (Mu)
McRury (McR)
Tracy (T)
Gardiner (G)
1000
2000
0
5km
LEGEND
LCR
Unnamed Redbeds
LCM-u
Morien Group
LCM-l
MAJOR HIATUS
ECPE
ECCD
ECuw
ECLw
GRF
MF
ECG
up to 600m
up to 1200m
250m
150m
1000m
STEPHANIAN
WESTPHALIAN
NAMURIAN
VISEAN
TOURNAISIAN
MORIEN GP
CANSO GROUP
WINDSOR GP
HORTON GROUP
LATE CARBONIFEROUS
EARLY CARBONIFEROUS
ROCK UNITS
G Grantmire Formation
PE Point Edward Formation
CD Cape Dauphin Formation
GRF Grays River Formation
MF Macumber Formation
SYMBOLS
Fault (high angle, thrust)
Geological boundary
Cross section
Fold axis (anticline, syncline)
Coal seam
Unconformity, disconformity
Hiatus
Facies boundary
Uncertain
Thickness where not to scale
50m
Mineral occurrence
Copper Cu
Lead Pb
Zinc Zn
Silver Ag
Barite Ba
Celestite Sr
Coal mine
vertical scale
500m

Figure 2. Continued.

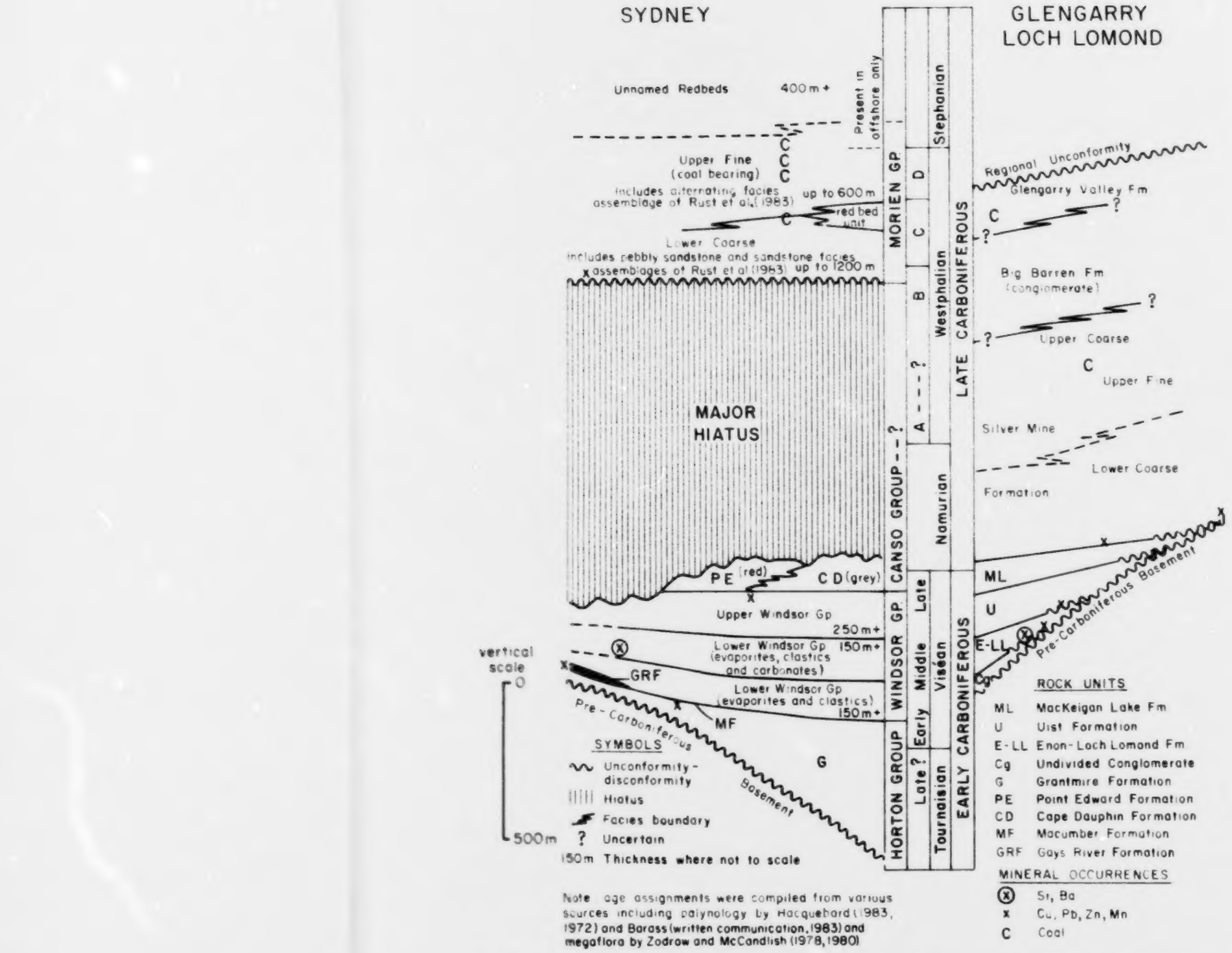
SYDNEY
GLENGARRY
LOCH LOMOND
Unnamed Redbeds 400m +
Present in offshore only
Stephanian
Upper Fine (coal bearing)
C C C
includes alternating facies assemblage of Rust et al.(1983)
up to 600m
red bed unit
Lower Coarse
includes pebbly sandstone and sandstone facies assemblages of Rust et al (1983)
up to 1200 m
MORIEN GP.
D C B A
Westphalian
LATE CARBONIFEROUS
Regional Unconformity
Glengarry Valley Fm
Big Barren Fm (conglomerate)
Upper Coarse
Upper Fine
Silver Mine
Lower Coarse
Formation
MAJOR HIATUS
CANSO GROUP
Namurian
PE (red)
C D (grey)
ML
U
E-LL
Cg
Pre-Carboniferous Basement
Upper Windsor Gp
250m+
Lower Windsor Gp (evaporites, clastics and carbonates)
150m+
Lower Windsor Gp (evaporites and clastics)
150m+
WINDSOR GP.
Late Middle Early
Viséan
EARLY CARBONIFEROUS
GRF
MF
G
Pre-Carboniferous Basement
HORTON GROUP
Late?
Tournaisian
vertical scale
0
500m
SYMBOLS
Unconformity - disconformity
Hiatus
Facies boundary
? Uncertain
150m Thickness where not to scale
ROCK UNITS
ML MacKeigan Lake Fm
U Uist Formation
E-LL Enon-Loch Lomond Fm
Cg Undivided Conglomerate
G Grantmire Formation
PE Point Edward Formation
CD Cape Dauphin Formation
MF Macumber Formation
GRF Gays River Formation
MINERAL OCCURRENCES
ⓧ Sr, Ba
x Cu, Pb, Zn, Mn
C Coal
Note age assignments were compiled from various sources including palynology by Hacquebard (1983, 1972) and Barass (written communication, 1983) and megaflora by Zodrow and McCandlish (1978, 1980)

Figure 3. Stratigraphic summary of Sydney Basin, Glengarry Half Graben and Loch Lomond Basin.

The Upper Windsor in the Sydney Basin consists of up to 250+ m of interstratified fine siliciclastics, fossiliferous marine carbonates, gypsum and anhydrite. It rests concordantly (disconformably?) upon the underlying Lower Windsor. The correlative and lithologically similar section in the Loch Lomond-Glengarry Half Graben is the Uist Formation which is up to 135 m thick.

The Upper Windsor in the Sydney Basin is conformably overlain by the Cape Dauphin Formation and/or Point Edward Formation which together comprise up to 200 m of grey and red fine grained fluvial-lacustrine siliciclastics with minor algal lacustrine and pedogenic limestone and rare nodular anhydrite. The MacKeigan Lake Formation (Prime, 1983) is the correlative section in the Loch Lomond-Glengarry Half Graben. It is very similar lithologically (Prime, 1983) and is generally less than 100 m thick.

The top of this succession in the Sydney Basin is truncated by a regional unconformity beneath the Late Carboniferous Morien Group (Fig. 3). The coarse pebbly sandstone facies at the base of the Morien Group may rest on strata as old as the middle part of the Upper Windsor. A major hiatus from Late Namurian (Late Viséan with erosion) through to the Late? Westphalian B is indicated in the stratigraphic record.

In contrast, no major unconformity-hiatus is recognized in the Loch Lomond-Glengarry Half Graben where the Late Viséan-Namurian section is up to 1000+ m in thickness and appears to be relatively complete. Nomenclature for this package will be formally introduced (Prime, 1983) in a subsequent final report (in preparation).

In general the section comprises in ascending order above the MacKeigan Lake Formation: an alluvial depositional package (Silver Mine Formation) with two subdivisions consisting of a lower 225 m of coarse grey sandstone with minor shale, gradational upwards to 395 m of interbedded grey to red fine siliciclastics with minor coal. The base of the section is concordant to disconformable with shales of the underlying MacKeigan Lake Formation.

The Silver Mine Formation is gradational upward into a thick gravelly braided river-alluvial fan sequence (Big Barren Formation) comprising from 275 to 700 m of well rounded red conglomerate and sandstone. The Big Barren Formation in turn is transitional upwards with up to 300 m of interbedded green grey to red fine siliciclastics and minor coal seams (Glengarry Valley Formation) representing alluvial (braid plain-flood plain) deposition. This Formation is approximately time equivalent to the lower part of the Morien Group in the Sydney Basin (Barss, written communication, 1983; Hacquebard, 1972).

The Morien Group is a predominantly grey alluvial succession up to 1800 m thick and is subdivided into 3 principal map units: (1) a lower, coarse unit including sandstone and pebbly sandstone facies assemblages of Rust et al. (1983), (2) an upper fine unit including alternating facies assemblage of Rust et al. (1983), and (3) a highly calcareous redbed unit in the Wadden Cove area on the eastern side of the basin. The top of the Morien Group is known only from drillholes in the offshore extension of the

Sydney Basin (Figs. 2 and 3). The Group appears to be transitional upwards into a dominantly red sandstone-siltstone redbed succession up to 400 m thick. Hacquebard (1983) indicated that these redbeds were not older than Stephanian (Latest Carboniferous) in age and might extend into the Permian.

Major economic coal deposits are confined to the upper fine facies of the Morien Group with thin, typically subeconomic coal seams present rarely in the lower coarse facies. Rust et al. (1983) concluded that the Morien Group represented primarily alluvial deposition in sandy braid plain environment in the lower coarse facies and in a low slope, low energy alluvial plain environment with high sinuosity rivers in the upper fine facies. The coal deposits in the upper fine facies resulted from extensive development of peat due to continual compaction of the dominant mudrocks.

CONCLUSIONS

The apparent disparity in the stratigraphic records in the Sydney Basin and Loch Lomond Basin-Glengarry Half Graben is problematical given their present day proximity. The hiatus may be smaller than indicated in Figure 3 if results from palynology sampling at the base of the Morien allow more precise placement of this important boundary. It is difficult to conceive that a section similar to and correlative with the Silver Mine and Big Barren Formations has escaped recognition in the Sydney Basin. The presence of a hiatus, therefore, seems well established and its origin requires examination.

The Sydney Basin and Loch Lomond Basin-Glengarry Half Graben are separated by a major fault system comprising the Lennox Passage, Grand River and Mira River-Bateston Faults that extends northeasterly to easterly from the Strait of Canso to Mira Bay (Fig. 1). The Carboniferous rocks on the northern part of the Fourchu Block are all part of a progressive onlap suite described by Boehner (1981, 1983). The highly deformed Devono-Carboniferous rocks in the L'Ardoise Graben were described by Boehner (1983) as being allochthonous and were probably brought into the area by transcurrent movement (right lateral?) on the boundary faults including the Grand River-Lennox Passage Faults (Fig. 1). The boundary faults have an inferred vertical displacement of greater than 800 m and probably kilometres of right lateral offset. The Grand River-Lennox Passage-Bateston Faults extend to the northeast and form the northwestern border of the Loch Lomond Basin and Glengarry Half Graben, and the southern border of the Sydney Basin. Large transcurrent motion on this fault system is postulated to explain, in part, the present close proximity of the two areas. Intra-Carboniferous tectonism, including block faulting and folding, accompanying? transcurrent faulting, may explain the hiatus (uplift erosion-nondeposition) in the Sydney Basin and the more complete stratigraphic record including the appearance of the peculiar Big Barren Formation in Glengarry Half Graben. It is not certain if the two areas represent juxtaposed fragments of two discrete depositional basins or are dismembered portions of a single large sedimentary basin. Details of paleogeography and fault motion history require further analysis. The sequence of events related to the Grand River-Lennox Passage and Bateston Faults are as yet unclear.

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PRELIMINARY REPORT ON THE GEOLOGY OF THE GLENGARRY HALF GRABEN AND VICINITY, CAPE BRETON ISLAND, NOVA SCOTIA*

G. Prime and R. C. Boehner

ABSTRACT

Intensive exploration in the Glengarry Half Graben area of southeastern Cape Breton Island, Nova Scotia, has established the presence of economic deposits of lead, celestite, and barite. Because of the importance of this Carboniferous structural basin and the large amount of data available, the present study was undertaken to better understand its stratigraphy and sedimentary history. Surface mapping of all outcrop exposure and logging of selected diamond-drill core were the methods employed.

Preliminary results indicate that the Glengarry Half Graben consists of approximately 2000 m of primarily continental siliciclastics, minor limnic or paralic shales, limestones, evaporites, and very minor marine carbonates. The strata are Viséan to Late Westphalian in age and occur in an asymmetric syncline. The Half Graben has a similar stratigraphy and sedimentology to the adjacent Loch Lomond Basin. In both areas, the strata record a history of progressive onlap. Outlier remnants of similar facies occur to the south on the Fourchu Block near Gabarus and to the east near Catalone and Bateston. The Glengarry Half Graben is inferred to be a remnant of a much larger depositional system.

INTRODUCTION

The Glengarry Half Graben (Salmon River Basin) of Keppie (1982) is a small (125 km^2), elongate structural basin of Carboniferous age (Fig. 1). The Half Graben, located south of the larger Sydney Basin, strikes northeast. To the northwest, it is bounded by the Lennox Passage Fault, a northeasterly trending, high angle fault that separates it from the East Bay Block Hadrynian-Devonian igneous basement. To the southwest, a northwesterly trending, high angle, transverse fault separates the Half Graben from the structurally similar Loch Lomond Basin. The southeastern boundary is an angular unconformity with the Fourchu Block comprising Hadrynian-Devonian metasedimentary and igneous rocks.

PREVIOUS WORK

Mineral exploration has been recorded in the area for about a century, but has been especially active during the past 20 years. In the late nineteenth and early twentieth centuries, mining operations extracted small amounts of manganese along McCuish Brook and coal at Glengarry. More

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*Contribution to Canada-Nova Scotia Co-operative Mineral Program 1981-84. Project carried by Nova Scotia Department of Mines and Energy and by Geological Survey of Canada.

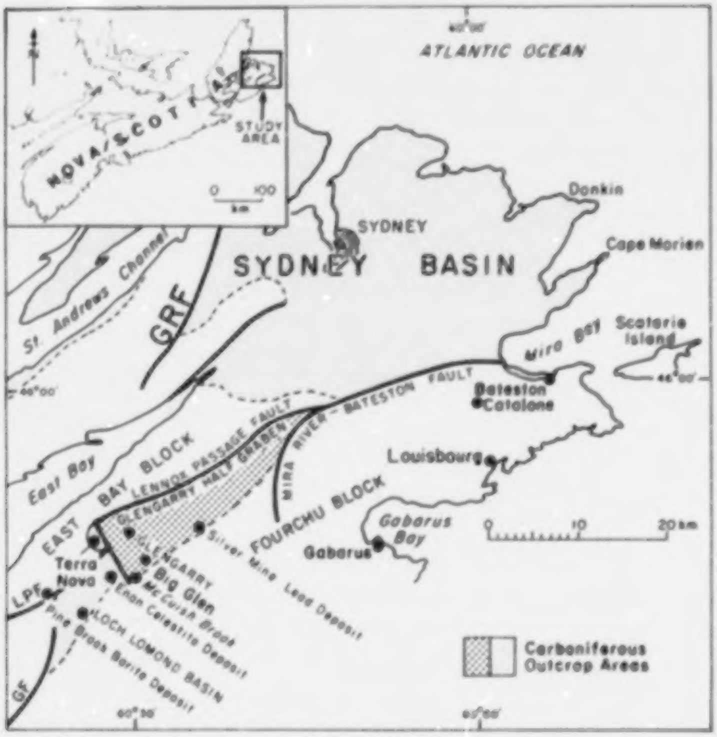
NOVA SCOTIA
STUDY AREA
0 100
km
ATLANTIC OCEAN
Donkin
SYDNEY
SYDNEY BASIN
Cape Morien
St. Andrews Channel
GRF
Mira Bay
Scaterie Island
46°00'
Bateston
Catalone
Louisbourg
MIRA RIVER - BATESTON FAULT
LENNOX PASSAGE FAULT
GLENGARRY HALF GRABEN
East Bay
EAST BAY BLOCK
FOURCHU BLOCK
Gabarus Bay
Gabarus
0 10 20 km
Terra Nova
LPF
GLENGARRY
Big Glen
McCuish Brook
Enon Celestite Deposit
Silver Mine Lead Deposit
LOCH LOMOND BASIN
Pine Brook Barite Deposit
GF
60°30'
Carboniferous Outcrop Areas

Figure 1. General geological setting of the Sydney Basin, Glengarry Half Graben, and Lock Lomond Basin. Carboniferous rocks in patterns. GF= Grand River Fault; GRF= George River Fault; LPF= Lennox Passage Fault (nomenclature modified from Keppie, 1982).

recently, celestite has been mined at Enon (1970-1976) and lead at Silver Mine (1979-1981). Both operations have subsequently closed due to economic problems. An open-pit barite mine operated by Novex Mining and Exploration Ltd. is located at Pine Brook near Loch Lomond. The intensive mineral exploration in the area has provided access to voluminous subsurface information comprising approximately 25 000 m of diamond-drill core.

In addition, several geological maps and reports on the area have been compiled (e.g. Weeks, 1954; Scott, 1978; Boehner, 1981, 1983; Keppie, 1982; Bonham et al., 1982).

OBJECTIVES AND METHODS

This study's principal objective was to examine and describe in detail the stratigraphy and sedimentology of the Glengarry Half Graben. Methods employed included field mapping of all outcrop and logging of selected diamond-drill holes in a series of cross-sections. Data collected included the measurement and description of new lithostratigraphic units, measurement of paleocurrent directions, and examination of conglomerate clast lithology. Sandstones were sampled for petrographic examination, shales for palynology and clay mineralogy, and coals for vitrinite reflectance. When complete, the project will provide an updated geological map, a modern lithostratigraphic framework, and an increased understanding of the sedimentary history of the Glengarry Half Graben.

STRATIGRAPHY AND SEDIMENTOLOGY

The sedimentary sequence within the Half Graben (Figs. 2 and 3) consists primarily of fine- to coarse-grained continental siliciclastics and to a lesser extent, paralic or limnic shales, limestones, evaporites and marine carbonates. Age assignments used in this report are based upon palynology of shales sampled systematically through the entire section available and were kindly provided by M. S. Barss of the Atlantic Geoscience Centre, Geological Survey of Canada. This does not, however, imply agreement with the interpretation of the results presented in this report. The Carboniferous strata range in age from Late Viséan to Late Westphalian and comprise a relatively complete sequence without major disconformity-unconformity. The lithology and stratigraphy of the Carboniferous rocks in the Glengarry Half Graben and Loch Lomond Basin (Figs. 2, 3 and 4), together with the similar structure, strongly indicate these two structural basins formed part of a border of a formerly continuous depositional area on what is presently the northwestern side of the Fourchu Block. Thin outlier remnants of onlapping Windsor Group (Loch Lomond and Uist Formations) are known to occur near Bateston, Catalone, Gabarus and Louisbourg (Fig. 1).

The strata in the Glengarry Half Graben form an asymmetric syncline with beds generally dipping gently toward the centre where a maximum thickness of 2000 m is projected. They rest with distinct nonconformity-angular unconformity upon variably deformed sedimentary, volcanic, and intrusive rocks of the Hadrynian-Devonian Fourchu Block (Figs. 1 and 2).

Carboniferous rocks within the Glengarry Half Graben are described in ascending order in the following paragraphs. Unconformably overlying the basement on the southeastern border is the Uist Formation, which is a complex wedge of sedimentary breccia, coarse angular to subrounded conglomerate and minor limestone-dolostone (92-140 m thick). The coarse siliciclastics represent talus breccia and proximal alluvial fan deposits, respectively. Conformably overlying this sequence, and occasionally interbedded with it, is brown, massive, sparsely fossiliferous dolostone (Big Glen Member) (<17 m). Its precise paleoenvironment is not known, but it contains shelly and coral fauna of marine origin and is lithologically similar to the B_1 limestone.

Conformably overlying the limestone at the top of the Uist Formation is the MacKeigan Lake Formation, a sequence beginning with green or red siltstone (<4 m) followed by interbedded grey shale, limestone, and

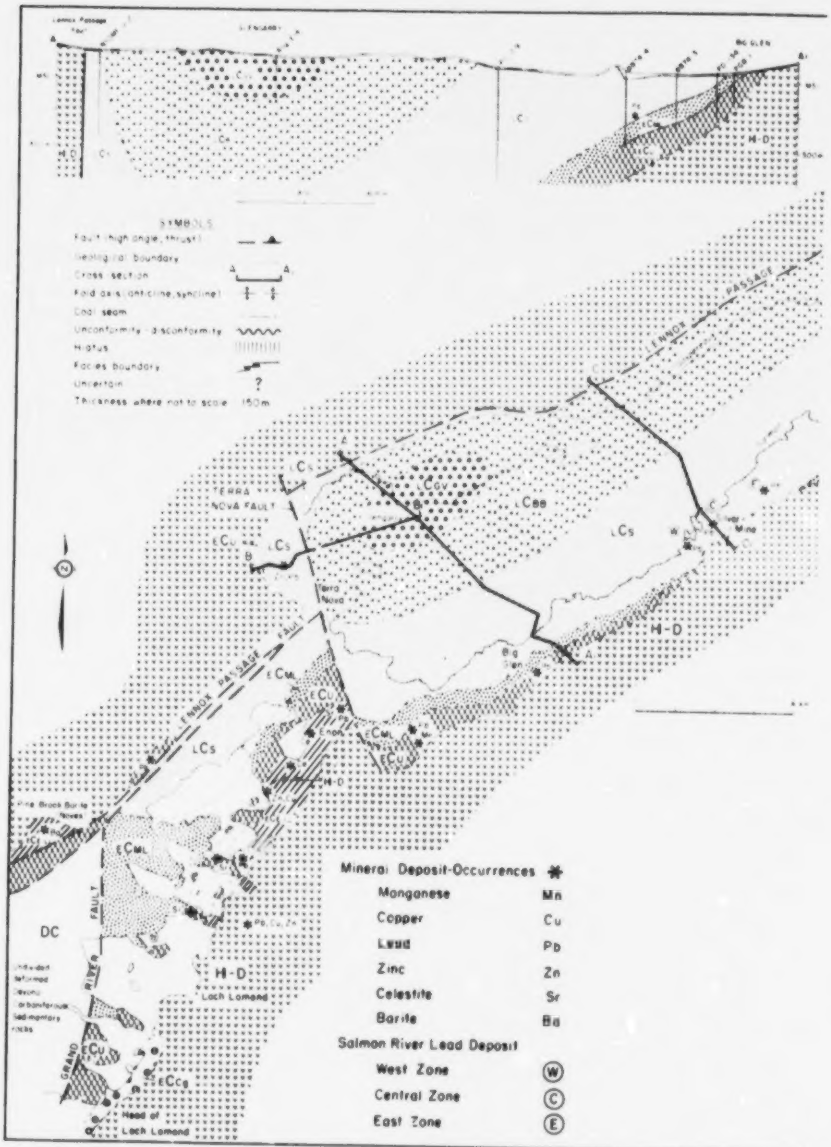
Lennox Passage Fault
A
A₁
H-D
Glen
SYMBOLS
Fault (high angle, thrust)
Geological boundary
Cross section
Fold axis (anticline, syncline)
Coal seam
Unconformity - disconformity
Hiatus
Facies boundary
Uncertain
?
Thickness where not to scale
150m
LENNOX PASSAGE
LENNOX PASSAGE FAULT
TERRA NOVA FAULT
Terra Nova
LCs
LCsv
LCss
ECu
ECML
B
B₁
C
C₁
Big Glen
Enon
H-D
DC
Undivided deformed Devono-Carboniferous sedimentary rocks
GRAND RIVER FAULT
ECCg
Loch Lomond
Head of Loch Lomond
Pine Brook Barite
Mineral Deposit-Occurrences
Manganese
Mn
Copper
Cu
Lead
Pb
Zinc
Zn
Celestite
Sr
Barite
Ba
Salmon River Lead Deposit
West Zone
Ⓦ
Central Zone
Ⓒ
East Zone
Ⓔ

Figure 2. Preliminary simplified geological map and cross-sections A-A$_1$, B-B$_1$, and C-C$_1$, Glengarry Half Graben and Salmon River Basin.

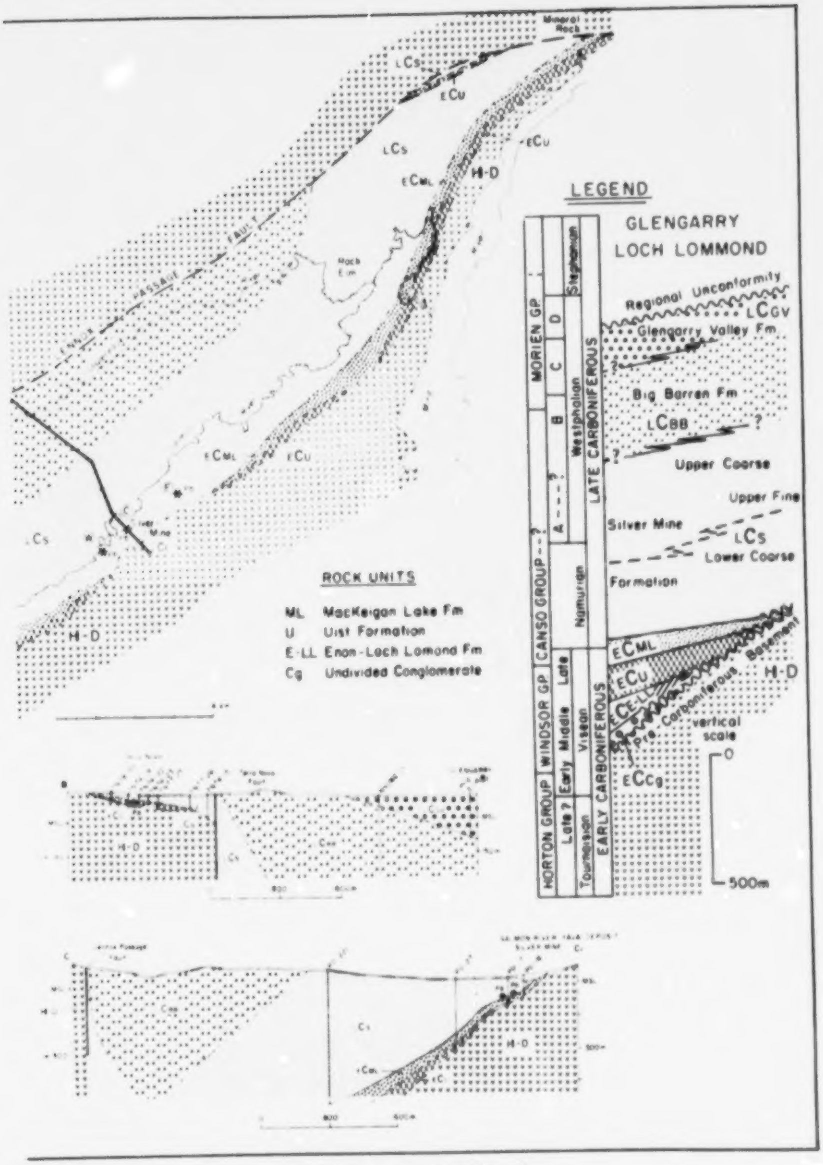
Mineral Rock
LCs
ECu
LCs
ECu
ECML
H-D
FAULT
Mock Em
ECML
ECu
Silver Mine
LCs
H-D
LEGEND
GLENGARRY
LOCH LOMMOND
Regional Unconformity
LCGV
Glengarry Valley Fm
Big Barren Fm
LCBB
?
Upper Coarse
Upper Fine
Silver Mine
LCs
Lower Coarse
Formation
ECML
ECu
ECE-LL
H-D
Pre-Carboniferous Basement
vertical scale
0
500m
ECCg
MORIEN GP.
CANSO GROUP
WINDSOR GP.
HORTON GROUP
A
B
C
D
Late ?
Early
Middle
Late
Stephanian
Westphalian
Namurian
Visean
Tournaisian
LATE CARBONIFEROUS
EARLY CARBONIFEROUS
ROCK UNITS
ML MacKeigan Lake Fm
U Uist Formation
E-LL Enon-Loch Lomond Fm
Cg Undivided Conglomerate
H-D
Cs
H-D
Cs
500m

Figure 2. Continued

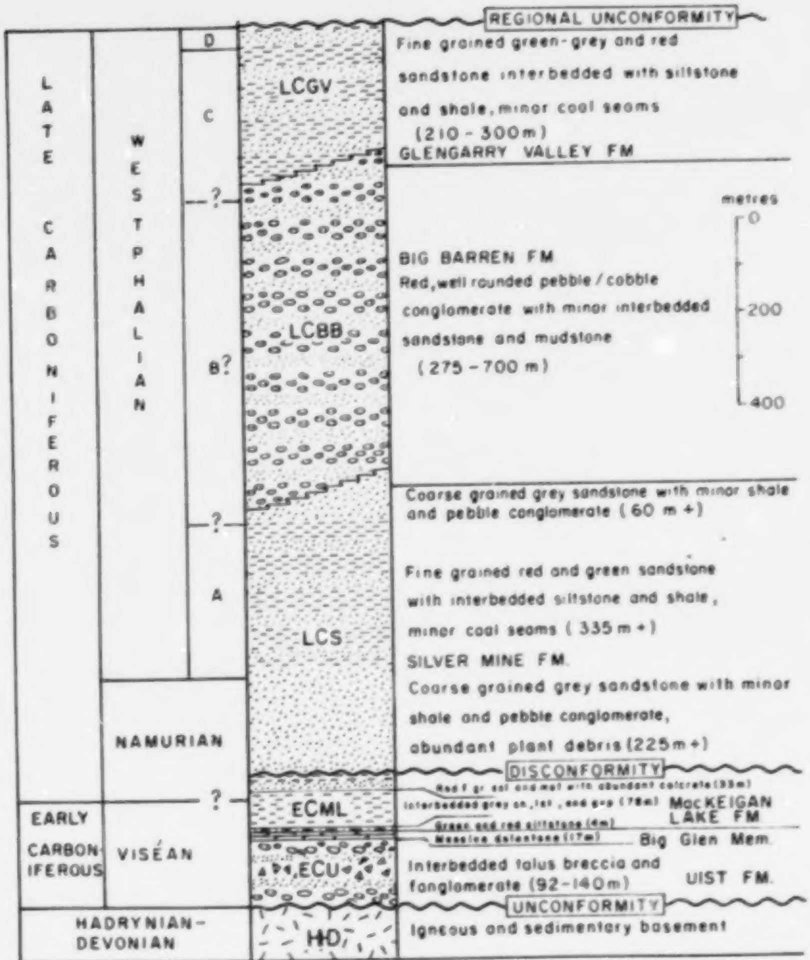
REGIONAL UNCONFORMITY
LATE CARBONIFEROUS
WESTPHALIAN
D
C
B?
A
?
?
LCGV
Fine grained green-grey and red sandstone interbedded with siltstone and shale, minor coal seams (210 - 300m)
GLENGARRY VALLEY FM
metres
0
200
400
LCBB
BIG BARREN FM
Red, well rounded pebble / cobble conglomerate with minor interbedded sandstone and mudstone (275 - 700 m)
Coarse grained grey sandstone with minor shale and pebble conglomerate (60 m +)
LCS
Fine grained red and green sandstone with interbedded siltstone and shale, minor coal seams (335 m +)
SILVER MINE FM
Coarse grained grey sandstone with minor shale and pebble conglomerate, abundant plant debris (225m +)
NAMURIAN
DISCONFORMITY
?
EARLY CARBONIFEROUS
VISÉAN
ECML
Red f gr sst and mst with abundant calcrete (33m)
Interbedded grey ss, lst, and gyp (78m)
Green and red siltstone (4m)
Massive dolostone (17m)
MacKEIGAN LAKE FM
Big Glen Mem
ECU
Interbedded talus breccia and fanglomerate (92-140m)
UIST FM
UNCONFORMITY
HADRYNIAN-DEVONIAN
HD
Igneous and sedimentary basement

Figure 3. General stratigraphy of the Glengarry Half Graben, Cape Breton Island, Nova Scotia.

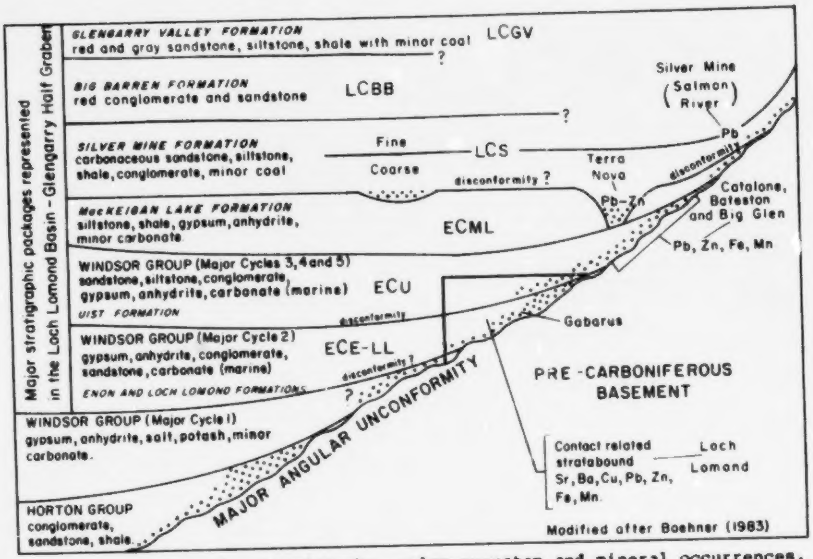
Major stratigraphic packages represented in the Loch Lomond Basin - Glengarry Half Graben
GLENGARRY VALLEY FORMATION
red and gray sandstone, siltstone, shale with minor coal
LCGV
?
BIG BARREN FORMATION
red conglomerate and sandstone
LCBB
?
SILVER MINE FORMATION
carbonaceous sandstone, siltstone, shale, conglomerate, minor coal
Fine
Coarse
LCS
disconformity ?
Silver Mine
(Salmon River)
Pb
Terra Nova
Pb-Zn
disconformity
MacKEIGAN LAKE FORMATION
siltstone, shale, gypsum, anhydrite, minor carbonate
ECML
Catalone, Bateston and Big Glen
Pb, Zn, Fe, Mn
WINDSOR GROUP (Major Cycles 3, 4 and 5)
sandstone, siltstone, conglomerate, gypsum, anhydrite, carbonate (marine)
ECU
UIST FORMATION
disconformity
Gabarus
WINDSOR GROUP (Major Cycle 2)
gypsum, anhydrite, conglomerate, sandstone, carbonate (marine)
ECE-LL
disconformity ?
ENON AND LOCH LOMOND FORMATIONS
?
PRE-CARBONIFEROUS BASEMENT
WINDSOR GROUP (Major Cycle I)
gypsum, anhydrite, salt, potash, minor carbonate.
MAJOR ANGULAR UNCONFORMITY
Contact related stratabound Sr, Ba, Cu, Pb, Zn, Fe, Mn.
Loch Lomond
HORTON GROUP
conglomerate, sandstone, shale.
Modified after Boehner (1983)

Figure 4. Schematic stratigraphy, onlap-overstep and mineral occurrences, Loch Lomond Basin-Glengarry Half Graben, Cape Breton Island, Nova Scotia.

gypsum (<78 m). The gypsum gradually decreases upwards and the unit is transitional with an uppersection of fine grained red sandstone and mudstone (<33 m). The MacKeigan Lake Formation sequence indicates that arid to semiarid conditions in a limnic or paralic environment existed with gradual moderation of the climate followed by the replacement of standing water deposition by fluvial sedimentation. A disconformity at the top of the fine grained siliciclastic-evaporitic sequence is represented by a caliche soil.

The overlying Silver Mine Formation has a three part subdivision comprising a lower sequence of medium- to coarse-grained grey sandstone (>225 m) that shows a subtle transition upward into a red to grey green, finer grained unit (>335 m) with increased mudstone and minor coal. This indicates a distal braided river system gradually changing upward to a meandering river system. At the top of the Silver Mine Formation, a coarse sandstone (>60 m) appears again, representing a return of braided river conditions.

The Silver Mine Formation sandstone is transitional with the overlying Big Barren Formation. This distinctive unit comprises interbedded, well-rounded red conglomerate, sandstone and mudstone (275-700 m) representing either a proximal braided river or a braidplain. The Big Barren Formation succession is transitional with the overlying Glengarry

Valley Formation. This fine grained green-grey sandstone, shale and coal sequence (210-300 m) represents a combination of fluvial and limnic or paralic sedimentation.

PALEOCURRENT DATA

Because of the limited and typically poor outcrop exposure in the area, paleocurrent data are difficult to measure. A total of 25 reliable measurements from primary current lineations and trough intersections were obtained (Fig. 5). Of these, 18 bidirectional readings from the Silver Mine Formation indicated a general N-S to NNE-SSW trend. In the Glengarry Valley Formation a trend of northeast-southwest was indicated from seven bidirectional measurements. These data, although few in number, are consistent with a general paleocurrent (axial?) transport direction parallel to subparallel with the present day structural trend (of northeast-southwest). In areas along the southeastern border, the influence of radial flow direction from the Fourchu Block basement may be indicated in the strong north-south trend within the Silver Mine Formation.

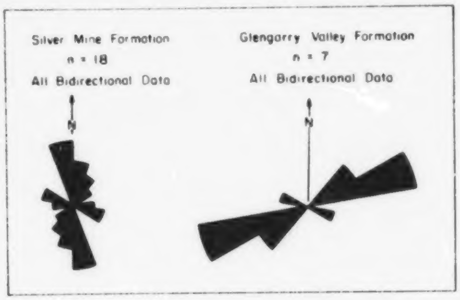

Figure 5. Paleocurrent data, Glengarry Half Graben. Primary current lineations and trough intersections.

CONCLUSIONS

The Glengarry Half Graben appears to be a remnant of a much larger sedimentary basin. The limited paleocurrent data gathered suggest that there was a northerly or northeasterly oriented trunk stream in the Basin throughout much of its development. Comparison of stratigraphic and sedimentological patterns with the Loch Lomond Basin indicates a strong correlation between the two. The Glengarry Half Graben strata appear to represent progressive onlap of stratigraphic units (similar to the Loch Lomond Basin). A similar situation occurs at Gabarus where an onlap outlier of bank facies limestone (B_2 Limestone) rests directly on basement. Uist Formation (Big Glen Member) strata onlap Fourchu Block basement rocks in outliers at Catalone and Bateston.

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SEDIMENTOLOGY OF THE MORIEN GROUP NEAR ALDER POINT, SYDNEY BASIN*

M. R. GIBLING** and B. R. Rust***

ABSTRACT

The Morien Group at Alder Point (Westphalian D to Stephanian) comprises nearly 60 per cent sandstone and siltstone, 38 per cent mudstone, and 2 per cent coal. Small- and large-scale cross-stratification are the main sedimentary structures of the sandstones. The mudstones are massive or laminated. The strata are meandering river deposits with distinct sub-assemblages representing geomorphic regions of the alluvial plain. Thick units of trough crossbedded sandstone formed in channels and point bars; epsilon cross-stratified sandstone and siltstone formed in smaller channels; coarsening-upward sandstones formed as levees and fluviolacustrine sequences; and green and red mudstones with thin-bedded sandstone, coal and limestone, formed on floodplains. Paleocurrent data indicate northeastward transport for major channel sandstones and floodbasin sandstones, with flow at right angles to this direction for coarsening-upward levee deposits. Variability of paleoflow direction in channel deposits reflects the high sinuosity system with flow along the strike of lateral accretion sets. Several lines of evidence, including the distribution of coals, limestones, and carbonate nodules in red and green sandstones, indicate that the colour of the mudstones was a primary or early diagenetic feature. Peat swamps developed on floodplain mudstones and were terminated by flooding, the advance of levees, or the avulsion of major channels.

INTRODUCTION

The project is a study of the Upper Pennsylvanian Morien Group in the Sydney Basin, Nova Scotia, undertaken jointly with the Nova Scotia Department of Mines and Energy and the Geological Survey of Canada. During the 1983 field season, our work concentrated on the Morien Group west of Sydney Harbour, in the vicinity of Alder Point (Fig. 1). Strata from Alder Point east to North Sydney are described by M. A. Best (this volume).

The measured sections range from 60 m below the Bonar seam to 10 m above the Point Aconi seam, the youngest stratum on land in the Basin. The strata belong to the *Ptychocarpus unitus* zone (referred to informally as the upper Morien) of Bell (1938), the boundary of which was mapped by Bell and Goranson (1938a, b). The base of the zone (root of the Emery seam) roughly corresponds to a change in lithology throughout the area. Accurately defined lithostratigraphic units are being established by detailed mapping directed by the Nova Scotia Department of Mines and Energy. Subsequent to the work of Bell (1938), Zodrow and McCandlish

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*Contribution to Canada-Nova Scotia Co-operative Mineral Program 1981-84. Project carried by Nova Scotia Department of Mines and Energy and by Geological Survey of Canada.

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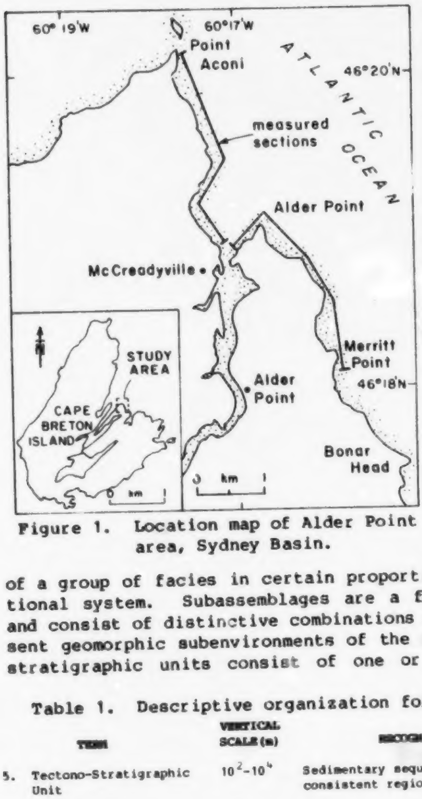

Figure 1. Location map of Alder Point area, Sydney Basin.

(1978, 1980), based upon extended ranges of guide fossils, abandoned the *Ptychocarpus unitus* zone and extended the *Linopteris obliqua* zone upwards to the Point Aconi seam. This report examines the depositional environment of the strata and the setting of the coals in the Morien Group near Alder Point. Some data are included from sections measured in the upper Morien above the Hub seam at New Waterford and Glace Bay in 1982.

DESCRIPTIVE METHOD

Five ranks of strata were examined ranging from small- to large-scale (Table 1). Facies are the basic units, and each represents a distinct process of sedimentation. Facies assemblages and subassemblages are groups of facies recognized in vertical section. Assemblages are several hundred metres thick, and consist of a group of facies in certain proportions that represent a major depositional system. Subassemblages are a few metres to tens of metres thick, and consist of distinctive combinations or sequences of facies; they represent geomorphic subenvironments of the depositional system. Formal lithostratigraphic units consist of one or more facies assemblages, or less

Table 1. Descriptive organization for the Morien Group, Sydney Basin.

TERM	VERTICAL SCALE (m)	RECOGNITION	SIGNIFICANCE
5. Tectono-Stratigraphic Unit	10^2-10^4	Sedimentary sequence with a consistent regional framework	Basin fill with a distinctive tectonic setting
4. Formal Lithostratigraphic Unit	10^2-10^4	Mappable units (group, formation, member)	Regional lithosome (3D sedimentary body from one or more environments)
3. Facies Assemblage	10^2-10^3	Group of facies which occur in vertical section in certain proportions.	Major depositional environment
2. Subassemblage	10^{-1}-10^2	Group of facies which occur repeatedly in vertical sections.	Geomorphic subenvironment
1. Facies	10^{-2}-10^1	Lithology (including sedimentary structures, fossils)	Distinct processes of sedimentation

commonly subassemblages, that have been mapped regionally. Tectonostratigraphic units are combinations of lithostratigraphic units, i.e. basinal fills in distinctive tectonic settings. Only the first three levels are discussed here.

FACIES DESCRIPTION

Ten facies were recognized in the Morien Group by Rust et al. (1983), following the classification of Miall (1978). Fieldwork in 1983 substantiated the validity of these facies, and a slightly modified list is shown in Table 2. A few points are clarified below:

1. A new facies, L, is introduced for bedded carbonate, whereas facies P represents nodular, pedogenic carbonate. The distinction may be arbitrary in the case (not observed in this study) of beds of coalesced nodules, as in some calcretes. Facies L may be calcitic, dolomitic or sideritic. Facies P does not form beds, but occurs as a significant component of other facies.

2. Facies Sp excludes large-scale heterolithic cross-strata (epsilon cross-stratification of Allen, 1963). The epsilon cross-strata contain discrete beds of several facies including St, Sr, Sh, Fl and Fm, and so are described separately from Sp.

3. Some fine grained sandstones were not assigned to any facies because the characteristic features were not observed. They are considered to be Sr and minor Sh that have undergone intensive bioturbation, and are not named separately because no new process was involved in their formation.

SUBASSEMBLAGES

Four main subassemblages of facies were identified in the sections at Alder Point and include: major sandstones, epsilon cross-stratified sandstone and siltstone, coarsening-upward sandstones, and mudstones.

MAJOR SANDSTONES (25 per cent of measured strata)

This association (Fig. 2) occurs as medium grained sandstone units commonly 3-5 m thick and in one instance 18 m thick. Very thick units contain intraclast layers and are probably stacked. The units show planar erosional bases, with about one metre of relief, and consist mainly of facies St (commonly deformed) with Sr, Sh and minor Sp; Sr predominates locally. Some units fine upward to siltstone with a trasition from St to Sr. Scour fills about one metre thick, roots, vertical tree trunks and large rotated mudstone intraclasts occur at the top. Epsilon cross-strata, slightly heterolithic, are observed locally with dips of about 10°, and paleocurrents indicate flow along strike of the cross-strata (Fig. 3). At New Waterford, large arthropod tracks trend along strike on the inclined surfaces. Major sandstones are laterally continuous for tens to hundreds of metres or more, but some fine laterally into siltstone.

Table 2. Facies of the Morien Group, Sydney Basin

FACIES SYMBOL	DESCRIPTION
G	Massive to poorly stratified pebble to granule conglomerate, with vascular plant fragments and intraclasts of mudstone and carbonate (Gm). Strata are rarely trough or planar cross-stratified (Gt or Gp).
St	Trough cross-stratified sandstone, mainly medium- to coarse-grained. Sets are usually grouped and up to 70 cm thick.
Sp	Planar-tabular cross-stratified sandstone, mainly medium- to coarse-grained. Sets are usually solitary and a few decimetres thick, locally up to 2.6 m thick.
Sh	Horizontally stratified sandstone, mainly fine- to coarse-grained. Current lineation is common, and the strata may dip at low angles (transitional into facies St).
Sr	Small-scale crosslaminated sandstone, mainly fine- to very fine-grained. Ripple-drift crosslamination is common.
Fl	Interlaminated shale, siltstone and very fine grained sandstone. Small-scale crosslamination, burrows and roots are locally common. Colour is mainly grey-green but locally red.
Fm	Massive mudstone, red or grey-green.
L	Carbonate units, including massive fine grained carbonates, laminated fossiliferous carbonates, stromatolites, and carbonate-rich siltstones and sandstones (calcretes). The units are continuous for tens of metres or more.
P	Nodules of siderite, or less commonly calcite or silica. Nodules are isolated, commonly in layers, or occur around roots (rhizoliths). They occur mainly in facies Fl, also in Fm, Sr and St, and do not form distinct beds.
C	Coal or carbonaceous shale.

EPSILON CROSS-STRATIFIED SANDSTONE AND SILTSTONE (5 per cent of strata)

This association was observed in five units in the measured sections, but was also noted elsewhere in the cliffs. The units consist of solitary, cross-stratified sets which range from 2.9 to 5.5 m in thickness and consist of fine- to very fine-grained sandstone and siltstone

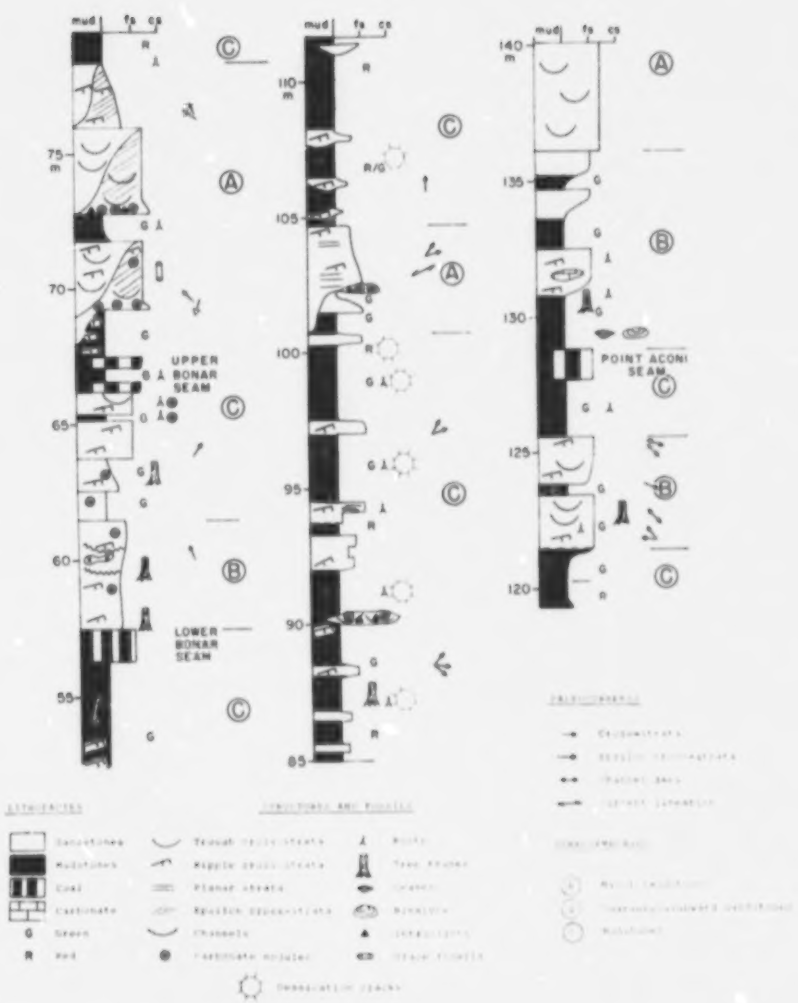
mud
fs
cs
75 m
70
65
60
55
UPPER BONAR SEAM
LOWER BONAR SEAM
110 m
105
100
95
90
85
140 m
135
130
125
120
POINT ACONI SEAM
Ⓐ
Ⓑ
Ⓒ
G
R
R/G
Sandstones
Mudstones
Coal
Carbonate
Green
Red
Trough cross-strata
Ripple cross-strata
Planar strata
Epsilon cross-strata
Channels
Carbonate nodules
Roots
Tree trunks
Bivalves
Trace fossils
Desiccation cracks

Figure 2. Lithofacies profiles from sections west of Alder Point, Sydney Basin, showing strata of the Alternating Facies Assemblage.

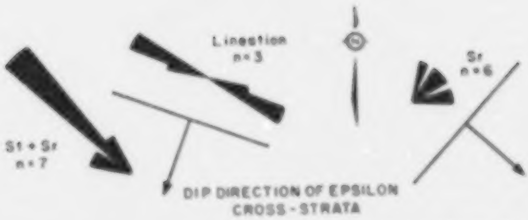

Figure 3. Paleocurrent data for epsilon cross-stratified units near Alder Point.

intercalated as inclined strata. Siltstone forms up to 80 per cent of the units. The basal surfaces of the units comprise facies Sr and Fm, with minor St, Sh and Fl. The epsilon sets dip at 3-16°, and commonly extend for less than 50 m. The units show little vertical ordering of facies, and are characterized by complex fills with erosion surfaces subparallel to the inclined strata. Paleocurrents indicate that flow was along the strike of the inclined surfaces. The units contain lensoid mudstones up to 1.5 m thick that fill erosional scours.

COARSENING-UPWARD SANDSTONES (25 per cent of strata)

Sixteen coarsening-upward units averaging 2.7 m in thickness and ranging from 1.4 to 6.0 m were recognized in the sections near Alder Point (Fig. 2). They grade up from mudstone (mainly Fm) to fine grained sandstone as beds of coarser grained sediment thicken and increase in proportion; three units fine upward slightly at the top. The main facies is Sr, commonly with ripple-drift crosslamination; St also occurs with set thickness increasing upwards. Bedding becomes lenticular upwards, and scours up to 70 cm deep and several metres wide are filled with St and Sr. Six coarsening-upward units contain vertical tree trunks, from 10 cm to 1.0 m in diameter and up to 2.0 m high (only three other units in the sections contain trunks). Root systems extend downward for 1.5 m below the trunks. Most of the sandstones not assigned to any facies occur in coarsening-upward units, and it is suggested that root penetration has destroyed much of the original stratification.

A different type of coarsening-upward unit occurs at Point Aconi, where the Point Aconi coal seam is overlain by 2.0 m of dark, fissile shale with lenticular carbonate bands, [illegible] valves and abundant leaves (Fig. 2). The shale coarsens upward into cross-stratified sandstone with roots and tree trunks.

MUDSTONES (45 per cent of strata)

This subassemblage (Fig. 2) consists mainly of mudstone units (Fm, Fl) intercalated with thin beds of sandstone and siltstone (Sr, Sn), coal (C) and limestone (L). The units are up to 17 m thick. The mudstones are grey-green or red; 95 per cent of Fl, 55 per cent of Fm, and 75 per cent of all mudstone is green. Most mudstone beds are planar, but a few thicken into lenses up to 1.5 m thick. Apart from lamination, the mudstones appear to contain few sedimentary features. Carbonate nodules and rhizoliths are common. Desiccation cracks which form polygons 1 m in diameter are visible on wave-cut platforms, and some extend for 1.5 m downwards. Colour mottling is present adjacent to the cracks, and some cracks contain carbonate nodules. Systems of curved, concave-up joints are present locally.

The mudstones contain numerous units of fine grained sandstone in planar beds 10-20 cm thick. Some units reach 1.5 m in thickness. The units consist of Sr and lineated Sh, show groove casts at the base, and commonly wedge out laterally. Many are uniform in grain size but some fine upward and coarsen upward locally, including several units about 1 m thick that fine upward to mudstone. Carbonate and mudstone intraclasts are present in some units. The contacts of some sandstone beds are diffuse, probably due to bioturbation.

Coals occur with the mudstones. The Lower Bonar seam is 1.4 m thick east of Alder Point, and contains mudstone partings and upward gradations from coal to carbonaceous mudstone. The Point Aconi seam is 1.0 m thick at Point Aconi, and contains lensoidal pyrite nodules 2 cm thick and 30 cm long. Other thin seams and carbonaceous partings are common. Most seams rest on pale grey mudstone with abundant roots and *Stigmaria* (seatearths), although a few rest on thin sandstone units (Sr). They are mostly overlain by grey mudstone, but major sandstones and coarsening-upward sandstones also overlie the coals. The Point Aconi seam is overlain by fissile shale with carbonate (see above). Tree trunks are rare in the mudstones and the few occurrences are associated with lensoid sandstones or rest on coal seams.

Limestones were not noted in the Morien Group section at Alder Point. At Glace Bay, two black laminated limestones 0.5-1.0 m thick are intercalated with facies Sr and Fl. They contain plant and fish fragments and phosphatic nodules. Red mudstones occur at several horizons in the Alder Point section. For the following reasons, the colour of the mudstones is believed to have originated at the surface or within a short time after burial:

1. Colour is not randomly distributed through the sections. Sections of green strata 40-50 m thick are intercalated with sections of red and green strata 4-40 m thick.

2. Interbedded red and green mudstone layers are continuous laterally for hundreds of metres without colour change. Erosional surfaces cut the colour-banded strata, suggesting that the colour differences were present at the time of erosion.

3. Coals and limestones occur only in green mudstone sections, and roots are abundant.

4. Carbonate nodules (facies P) occur in 32 per cent of green mudstone units (84 m total) but in only 4.5 per cent of red mudstone units (43 in total). Because the nodules are found as intraclasts in coarse grained facies, they evidently formed early in diagenesis at levels where they could be eroded and reworked. Hence the difference in proportions of

nodule-bearing red and green mudstones must reflect an original major difference in surface or shallow subsurface environment which correlates with colour.

5. Concave-up joints occur only in red mudstones.

FACIES ASSEMBLAGE

The upper Morien of the Alder Point area (at least 140 m of strata) belongs to the Alternating Facies Assemblage of Rust et al. (1983). The proportions of the facies in sections near Alder Point, New Waterford and Glace Bay are shown in Table 3. Sandstone and siltstone form nearly 60 per cent of the strata, mudstone nearly 40 per cent and coal 2 per cent. The predominant facies in order of abundance are Sr, Fm, St and Fl and sandstone not assigned probably belongs to Sr. In contrast, the Pebbly Sandstone and Sandstone Facies Assemblages in the lower Morien at South Bar contain only 7 per cent mudstone and less than 1 per cent coal, and the sandstones consist mainly of St.

Table 3. Proportions of facies in 450 m of the upper Morien, Sydney Basin

FACIES	% OF TOTAL STRATA	LITHOFACIES	%
G	0.4	Conglomerate	0.4
St	18.1		
Sp	0.2	Sandstone and siltstone	59.0
Sh	3.6		
Sr	22.6		
S (not assigned)	14.5		
Fl	16.2	Mudstone	38.4
Fm	22.2		
L	0.3	Carbonate	0.3
C	2.0	Coal	2.0

PALEOCURRENTS

The orientation of paleocurrent indicators in the Alternating Facies Assemblage of the Alder Point area indicates a northeasterly paleoflow direction (Fig. 4). This is consistent with the data for other parts of the Sydney Basin (Duff et al., 1982; Dilles and Rust, 1983; Giles, 1983; Rust et al., 1983). Large-scale trough cross-strata are the most reliable indicators, and show much less variability than small-scale cross-strata and primary current lineation.

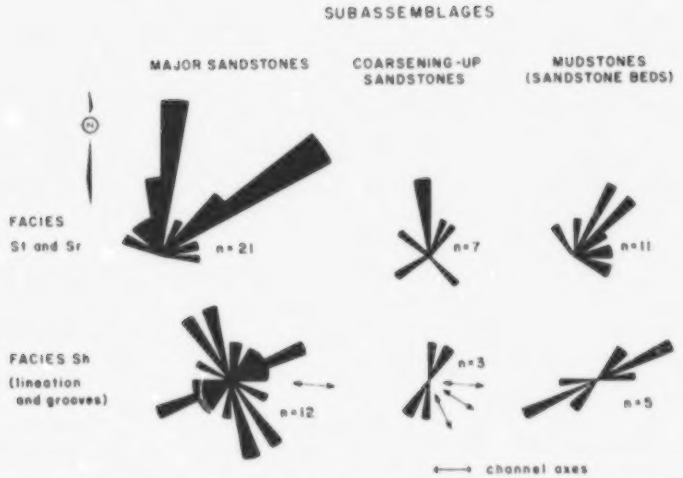

Figure 4. Paleocurrent data for the Alder Point area. Data grouped by subassemblages recognized in sections.

The four subassemblages show distinctly different paleocurrent patterns (Fig. 4). Each data point represents one discrete unit, or one level within a thick unit. Major sandstone units show a well-defined paleoflow towards the north or northeast. One epsilon cross-stratified unit shows a southeasterly paleoflow, outside the range for major sandstones. Coarsening-upward units show a high variability for cross-strata; elongate scours in the upper parts of the units are orientated northwest-southeast, at right angles to the trend for the major sandstones. Sandstone beds within the mudstone subassemblage show a northeasterly trend, with considerable variability.

DEPOSITIONAL ENVIRONMENTS

The Alternating Facies Assemblage contains many features characteristic of meandering river deposits (Rust et al., 1983). These include the abundance of mudstone and the significant proportion of coal. Mudstone and coal form a low proportion of the Pebbly Sandstone and Sandstone Facies Assemblage of the lower Morien, which were interpreted as braided river deposits by Rust et al. (1983) and Gibling and Rust (in press).

Meandering rivers are characterized by subenvironments (e.g. channels, point bars, levees, floodplains), with distinct geomorphic expression and different processes of deposition, which occur in an ordered spatial arrangement. Channel migration combined with aggradation results in characteristic patterns in vertical section. The Alternating Facies Assemblage is interpreted most usefully in terms of its component subassemblages, which represent subenvironments. They appear to be intercalated without significant vertical ordering.

MAJOR SANDSTONES

These are interpreted as fluvial channel and point bar deposits. Epsilon cross-strata represent point bar surfaces, although in many thicker units the surfaces appear to have been reworked in the scour hollows of migrating large dune systems. Rare solitary sets of planar crossbeds (Sp) probably represent small bars on the point bar surface. The tendency for upward change in sedimentary structures and local fining upward is characteristic of some modern point bars. Erosional scours, trunks and roots in the upper parts of the sequences indicate erosional modification with disturbance by vegetation at higher topographic levels.

Channel depths ranged from 3-10 m, judging from the thickness of single channel units. The lateral continuity, high width/depth ratio and planar bases of the units suggest that the channels migrated steadily by lateral accretion, with only periodic avulsion. Paleocurrents indicate a northeastward flow down the regional paleoslope, with variability attributable to the high sinuosity of the meandering system.

EPSILON CROSS-STRATIFIED SANDSTONE AND SILTSTONE

This subassemblage is distinctive but uncommon. Like the major sandstones, the units contain epsilon cross-strata which represent inclined point bar surfaces with paleoflow along strike. They differ in their heterolithic and fine grained nature (Sr and Fm predominate), smaller scale (commonly a few metres), complex internal geometry (lensoid units with scour-fills), and limited lateral extent. Some units may represent reduced flow in the same channel systems which formed the major sandstones, with point bars active periodically. Others may represent smaller scale tributary or distributary systems. Some units may be abandoned channels with inclined, asymmetric fills. Additional paleocurrent data may assist in separating these possibilities.

COARSENING-UPWARD SANDSTONES

These are interpreted as levee complexes with small-scale channels. The coarsening-upward trend is due to levee progradation or the migration of the meander belt towards the site of deposition. Progressively coarser sediment and larger scale bedforms resulted, with paleoflow at high angles to the flow in major channels. Ripple-drift crosslamination indicates rapid deposition. Local fining-up at the top suggests that the meander belt migrated away, whereas abrupt termination suggests that the nearest meander loop was cut off by avulsion. The levees supported large trees, whose preservation reflects rapid sedimentation. The lenticular bedding in part may represent the influence of vegetation on sedimentation, with scouring around trunks as well as deformation associated with root systems. Small-scale channels are oriented at right angles to the flow in major channels, suggesting that they were feeder channels for crevasse splays. The recurring coarsening-upward pattern implies steady migration of the parent meander belts. The abundance of this subassemblage in the sections (25 per cent) shows that levees were a major site of sedimentation.

The coarsening-upward sequence above the Point Aconi seam, with bivalves and abundant leaves in the lower part, is interpreted as fluvio-lacustrine, with sediment building out into shallow ponds on the floodplain.

MUDSTONE

This subassemblage is interpreted as floodplain deposits, and forms nearly half of the strata. The sandstone-siltstone units represent splays or the toes of prograding levees, and contain structures indicative of rapid flow. Paleocurrents show that, although variable, flow on the floodplain was predominantly down the major paleoslope, in contrast to the levee complexes where flow was mainly at right angles to the channel down the local paleoslope to the levee.

The mudstone units are floodbasin facies. The sediments have been partially or completely homogenized by bioturbation, and are essentially soils, with carbonate nodules (facies P). Reworked nodules testify to the ability of the flow to erode soils.

Groundwater level is believed to have been a major factor in sedimentation. Grey-green strata with coals, limestones and nodules represent periods when the water table was at or close to the surface, causing reduction of iron, peat growth in swamps, limestone formation in shallow lakes, and diagenetic formation of siderite. Red strata (25 per cent of all mudstone) resulted from a lower water table, which caused oxidation of iron and limited organic and chemical sedimentation. Sandstone and silstone beds and desiccation cracks occur in both groups. The evidence noted above for an early "fixing" of colour in the strata is an important feature of the sections.

The coal seams are extensive, and this may indicate that peat swamps periodically were established over large, inactive tracts of the alluvial plain. The swamps were forested at times, as shown by in situ trunks resting on the seams. Subsidence due to compaction of floodplain muds, perhaps assisted by loading from rapid build-up of levees, was probably the major factor in producing swamps. Peat growth was terminated by renewed sedimentation (overlain by mudstones and coarsening-upward units), excessive subsidence (overlain by lake deposits), or avulsion of channels (overlain by major sandstones). The mudstone subassemblage forms units up to 50 m thick, further indicating the stability and regular pattern of migration of the meander belts.

CONCLUSIONS

Work on the upper Morien Group to date has established that the coal-bearing strata are meandering river deposits, with distinctive subassemblages representing geomorphic elements of the alluvial plain. Formal lithostratigraphic units are being established from mapping by the Nova Scotia Department of Mines and Energy, which, in combination with stratigraphic analysis elsewhere in the Basin will facilitate regional synthesis. The correlation of coal resources and detailed petrography with the depositional and tectonic setting is an important goal of the study.

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THE SEDIMENTOLOGY OF THE UPPER MORIEN GROUP NEAR SYDNEY MINES, CAPE BRETON, NOVA SCOTIA*

M. A. Best**

ABSTRACT

The upper Morien Group (Westphalian C-D) is a meandering alluvial sequence with three major facies assemblages which are, in increasing order of volume: a sandstone facies assemblage, an alternating facies assemblage, and a mudstone facies assemblage.

The sandstone facies assemblage is dominated by trough crossbedded sandstones, which fine upward into ripple crosslaminated and horizontally laminated sandstones and siltstones. This assemblage is attributed to the fining upward sequence of a major meandering channel.

The alternating facies assemblage consists of alternating beds of sandstone, siltstone, mudstone and coal. The sandstone and siltstone are typically rippled and grade into each other; less commonly, they grade into mudstone and coal. This facies assemblage is attributed to deposition on levees, crevasse splays, and near-levee flood plains.

The mudstone facies assemblage consists of thick sequences of red and grey mudstones with major economic coal and minor siltstone beds. The association is attributed to extensive muddy flood plain and lacustrine deposition, with minor channel fill and thick peat accumulation.

INTRODUCTION

The Carboniferous Morien Group in the Sydney Basin, Cape Breton Island, Nova Scotia (Fig. 1), has been divided into three biostratigraphic zones based on megaflora by Bell (1938) that were equated to three spore assemblages by Barss and Hacquebard (1967) (Table 1). The boundaries of these zones were mapped across the Sydney Basin by Hayes et al. (1938) and Bell and Goranson (1938a,b,c). The boundary between the upper *Ptychocarpus unitus* zone and the middle *Linopteris obliqua* zone was placed at the Stony seam (also known as the Lingan or Emery seam). The boundary between the middle zone and the *Lonchopteris* zone was placed at the Tracy seam on the eastern side of the basin, but was arbitrarily marked on the basin's western side. The Morien Group was previously informally divided into the following upper and lower subdivisions; the Productive Coal Measures and Millstone Grit respectively (Robb, 1876). This is based on the presence of economic coal measures in the upper member. The upper subdivision coincides with the upper biostratigraphic zone, and the lower subdivision encompasses the lower two biostratigraphic zones (Table 1). Subsequent to

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*Contribution to Canada-Nova Scotia Co-operative Mineral Program 1981-84. Project carried by Nova Scotia Department of Mines and Energy and by Geological Survey of Canada.

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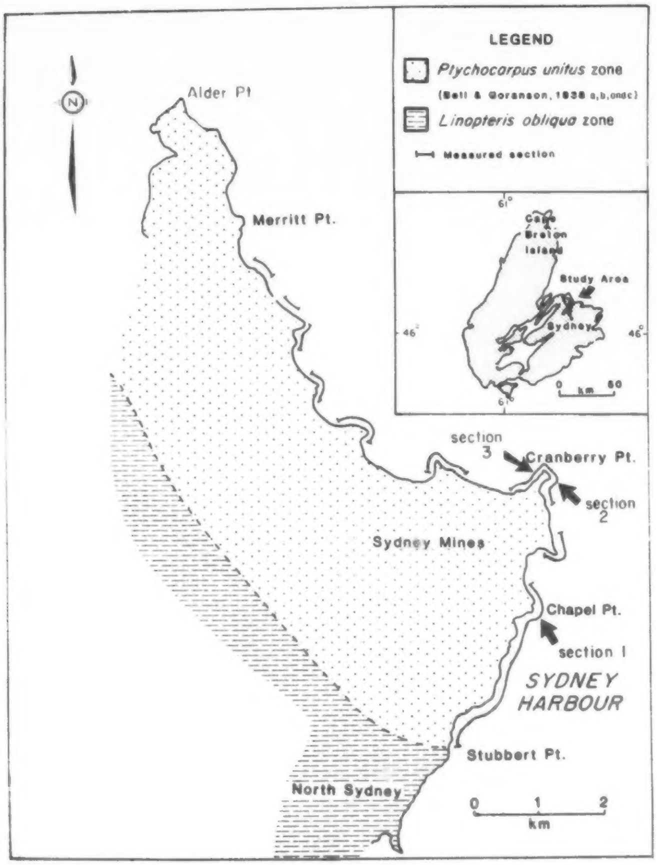

LEGEND
Ptychocarpus unitus zone
(Bell & Goranson, 1938 a,b,and c)
Linopteris obliqua zone
Measured section
61°
Cape Breton Island
Study Area
Sydney
46°
46°
0 km 50
61°
N
Alder Pt
Merritt Pt.
section 3
Cranberry Pt.
section 2
Sydney Mines
Chapel Pt.
section 1
SYDNEY HARBOUR
Stubbert Pt.
North Sydney
0 1 2
km

Figure 1. Location map of the study area within the Sydney Basin.

the work of Bell (1938), Zodrow and McCandlish (1978, and 1980) revised the biostratigraphy in light of further work on the megaflora of the Morien (Table 1). They have reported an extended distribution of *Lonchopteris eschweileriana* upwards into the *Linopteris obliqua* zone (Bell, 1938) and *Linopteris obliqua* upwards into the *Ptychocarpus unitus* zone (Bell, 1938). They consequently have introduced a modified two zone system consisting of *Lonchopteris eschweileriana* and *Linopteris obliqua* zones. They have abandoned the *Ptychocarpus unitus* zone and placed their boundary (and the Westphalian C-D boundary) at the roof of the Tracy seam (formerly Bell's, 1938, *Linopteris obliqua-Lonchopteris* boundary).

Table 1. Table of stratigraphic units within the Morien Group, Cape Breton Island, Nova Scotia.

AGE		ROBB (1876)	BELL AND GORANSON (1938a,b&c)	BARSS AND HACQUEBARD (1967)	ZODROW AND McCANDLISH (1978, 1980)	THIS REPORT (INFORMAL)
UPPER CARBONIFEROUS	Westphalian D	Productive Coal Measures	*Ptychocarpus unitus* zone	*Thymospora* zone C	*Linopteris obliqua* zone	upper Morien Group
	Westphalian C	Millstone Grit	*Linopteris obliqua* zone	*Torispora* zone B		lower Morien Group
			Lonchopteris zone	*Vestispora* zone A	*Lonchopteris eschweileriana* zone	

This report is based on a study of part of the upper Morien Group on the western side of the Sydney Basin (Fig. 1) and is part of the author's M.Sc. project at the University of Ottawa. Field work was performed in conjunction with the Nova Scotia Department of Mines and Energy. The study's aim is to assist in establishing clear lithostratigraphic units across the basin and to determine the depositional environments.

Detailed sections of coastal exposures were measured from Stubbert Point, near North Sydney to Merritt Point (Fig. 1). All sections were accessible at low tide. The Stubbert Point to Cranberry Point section offers the best continuous exposure of the upper Morien Group, complete as far upwards as the Point Aconi seam. Detailed observations of lithology, paleocurrents and facies types were made in all measured sections. In addition, drill core logs were studied and correlated, where possible, with the coastal exposures.

FACIES DESCRIPTIONS

Preliminary investigations based on lithology, sedimentary structures and initial petrology, allow extension of the facies previously described by Rust and Masson (1981) and Rust et al. (1983) into the western side of the basin. The facies were assigned codes after Miall's (1978) classification and the general descriptions are summarized as follows:

Facies St: Trough crossbedded sandstones are very coarse- to medium-grained, predominantly medium grained. Local accumulations consist of fine to very coarse plant debris, logs and pebble lag in trough bases. Coal mats (peat) occur at the bases of some sandstones. This facies averages 7 m in thickness. In places, compaction of underlying peats and muds has caused distortion of trough sets.

Facies Sp: Planar crossbedded sandstone is very rare, present only as a thin gradational unit from St to Sr. Generally, these are medium- to fine-grained and grade rapidly upward into rippled sandstones and downward into trough crossbedded sandstones.

Facies Sh: Horizontally bedded and laminated sandstones are not common, but do occur as a transitional phase associated with the rippled and calcareous sandstones. Facies Sh is generally fine grained sandstone to siltstone size and occurs in units less than 30 cm thick.

Facies Sr: Ripple crosslaminated sandstone (together with the mudstone (Fm) and interlaminated (Fl) facies) is a dominant facies type in the upper Morien Group. Facies Sr ranges from fine grained sandstone to siltstone, with asymmetric ripples of variable size and morphology. The beds are commonly very fissile due to abundant organic material. Deformation by bioturbation and compaction is common.

Facies Fl: Interlaminated shale, siltstone, very fine sandstone, and mudstone are common, with the individual rock types grading vertically into each other. This facies is rippled, horizontally laminated or massive, with bedding frequently disrupted by bioturbation and compaction. Organic debris, rootlets, in situ trees, and pedogenic carbonate nodules are common.

Facies Fm: Massive mudstones are commonly associated with Fl and Sr. The mudstones are red or grey. The red mudstones are commonly associated with the limestone or the calcareous siltstone and sandstone. Alternating beds of red and grey mudstones are common.

Facies Lst: Calcareous units vary from calcareous siltstone and sandstone, to limestone calcrete and discontinuous limestone beds. All fossils found by the author and those previously reported in the limestone units (Rust et al., 1983) have been nonmarine.

Facies P: Sideritic nodules are very common and occur throughout all the fine grained facies. Less common are calcitic nodules. Rust et al. (1983) reported silicic nodules, but these have not been observed by the author, although petrographic analysis is not yet complete. The nodules are commonly associated with roots occuring individually within beds, sometimes as discontinuous layers and sometimes as isolated concentrations on bedding planes.

Facies C: Coal and carbonaceous shales are common in the upper Morien Group. The carbonaceous shales generally occur as thin beds above and below coal seams. Thick (6 to 8 m) sequences of carbonaceous shales occur rarely. When they do, nonmarine pelecypods, ostracods, and coprolites are present. Coastal exposures of coal seams show the seams varying from 1 or 2 cm up to 50 cm in thickness. In situ trees are preserved as coalified bark with roots, in some cases extending into the coal seams.

FACIES ASSEMBLAGES

The following three facies assemblages were described by Rust et al. (1983): a pebbly sandstone facies assemblage, a sandstone facies assemblage and an alternating facies assemblage. In the study area, the author recognized two of these facies assemblages and observed a new assemblage.

SANDSTONE FACIES ASSEMBLAGE

The sandstone facies assemblage is present throughout the measured sections and comprises approximately 20 per cent of the succession. Facies in this assemblage are predominantly St and Sr, with minor amounts of Sp, Sh, Fm, and Fl. The assemblage occurs as fining upward sequences. The trough crossbedded sandstone fines upward into planar crossbedded sandstone, then ripple crossbedded sandstone and siltstone. Occasionally, these fine upward into mudstone and coal (Fig. 2). The finer units of these sequences are heavily rooted and contain abundant plant debris and concretions (Fig. 2). The bases of the trough crossbedded sandstones are both erosional and nonerosional. The nonerosional bases occur over coal seams (Fig. 2).

ALTERNATING FACIES ASSEMBLAGE

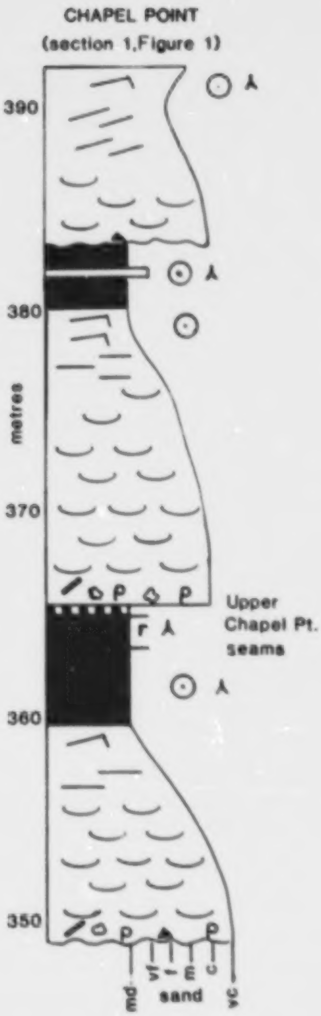
This assemblage consists of alternating beds of sandstone, siltstone, mudstone, and coal. The predominant facies types are Sr, Fm, Fl, and C, with minor amounts of Sh. Plant debris, in situ trees, roots and concretions are common. Mudstones are red and grey. Calcrete, calcareous sandstone, and siltstone are commonly associated with the red mudstone. The sandstones are fine- to very fine-grained; where bedding has not been disturbed by bioturbation, ripple crossbedding is observed. This assemblage comprises approximately 40 per cent of the total succession (Fig. 3a).

MUDSTONE FACIES ASSEMBLAGE

This assemblage comprises approximately 40 per cent of the upper Morien sucession and consists of approximately 80 per cent mudstone and 20 per cent coal and siltstone. In some cases the mudstones are rippled or horizontally laminated, but they are generally massive or so heavily bioturbated, that bedding is obscured. The siltstones are mostly calcareous and rippled. Contacts are predominantly gradational. This assemblage is found in the uppermost part of the upper Morien Group near Cranberry Point and just below the Point Aconi seam (Fig. 3b).

DEPOSITIONAL HISTORY

A terrestrial environment is indicated by the following: the lack of marine fauna; the presence of redbeds, coal seams, in situ trees and other rooted flora; and the abundance of plant debris. The presence of subordinate sandstone, predominantly thick accumulation of mudstones,


CHAPEL POINT
(section 1,Figure 1)
390
380
370
360
350
metres
Upper
Chapel Pt.
seams
r
p
md
vf
f
m
c
vc
sand

LEGEND

◡◡	trough crossbedded
//	planar crossbedded
═	horizontal bedding
⌒	ripple crossbedded
☐	sandstone
■	mudstone
▮▯▮	coal
md	mudstone
vf	very fine sandstone
f	fine sandstone
m	medium sandstone
c	coarse sandstone
vc	very coarse sandstone
○	concretion
⅄	roots
/	logs
▲	intraclasts
◇	pebbles
p	plant debris
)(	in situ trees
C	calcareous
r	red mudstone
VV	disturbed bedding
~	erosional contact
—	sharp contact

Figure 2. Stratigraphic log from Chapel Point (section 1, Figure 1) showing characteristic strata of the sandstone facies assemblage.

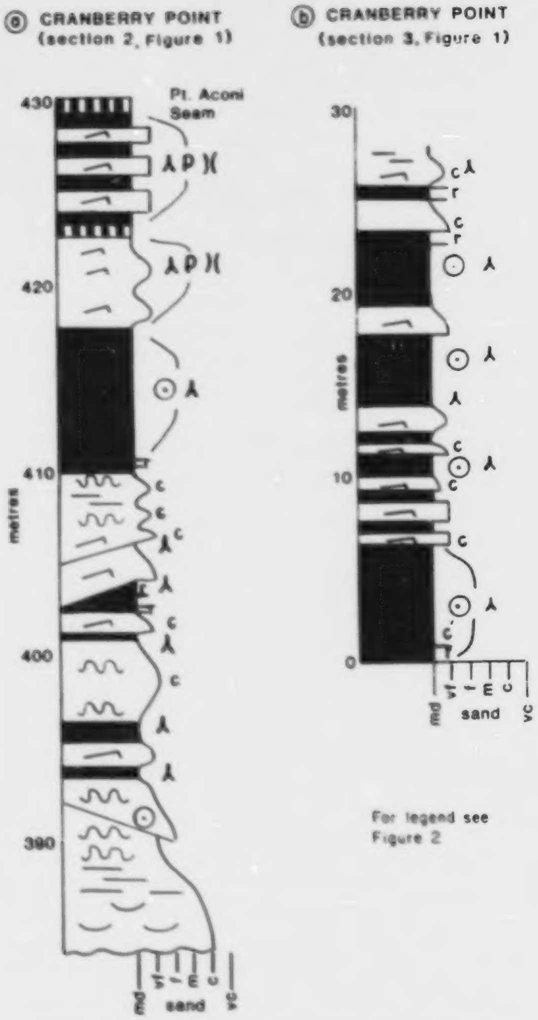

(a) CRANBERRY POINT
(section 2, Figure 1)
(b) CRANBERRY POINT
(section 3, Figure 1)
Pt. Aconi Seam
430
420
410
400
390
metres
30
20
10
0
metres
c
r
md
sl
f
m
c
sand
vc
For legend see Figure 2

Figure 3a. Stratigraphic log from Cranberry Point (section 2, Figure 1) showing strata characteristic of the alternating facies assemblage.

3b. Stratigraphic log from Cranberry Point (section 3, Figure 1) showing strata characteristic of the mudstone facies assemblage.

siltstones and coals, together with channel forms (abandoned channels which have later been infilled with mudstones), sigmoidal shaped lateral accretion deposits and highly variable paleocurrents (Fig. 4), fit closely with Jackson's (1978) model for meandering alluvial systems.

Units of the sandstone facies assemblage were deposited as fining upward sequences within the channels. The trough crossbedded sandstone fines upward into rippled sandstone in the upper part of the channels. The paleocurrents from the trough crossbedded sandstones show a variability of up to 120°, indicating a highly sinuous alluvial system of a major meandering channel (Figs. 4 and 5).

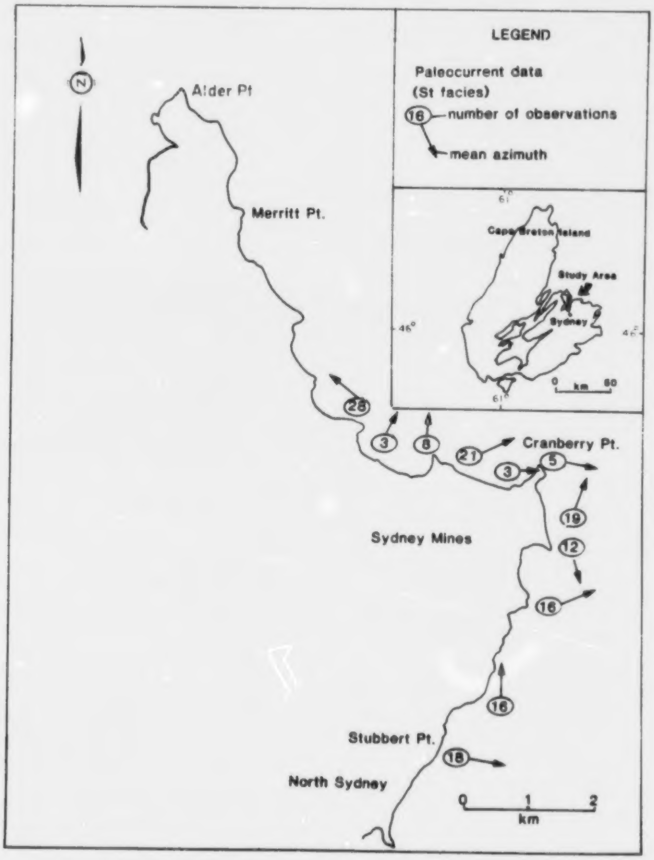
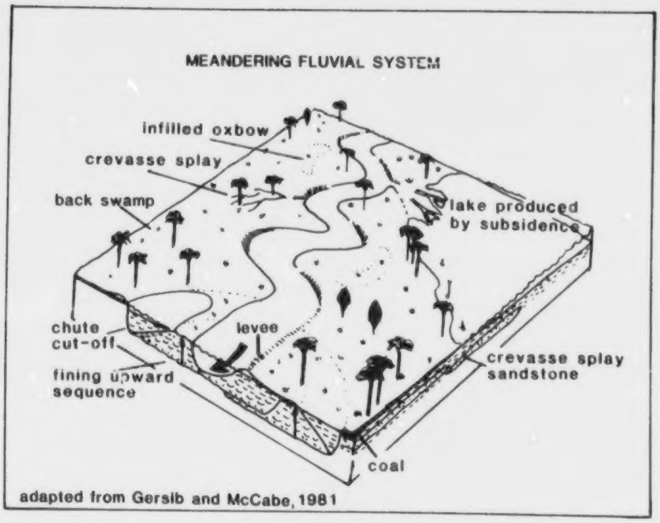

N
Alder Pt
Merritt Pt.
LEGEND
Paleocurrent data
(St facies)
16 number of observations
mean azimuth
61°
Cape Breton Island
Study Area
Sydney
46°
46°
0 km 60
61°
28
3
8
21
Cranberry Pt.
3
5
19
12
Sydney Mines
16
16
Stubbert Pt.
18
North Sydney
0 1 2
km

Figure 4. Mean paleocurrent vectors for trough crossbedded sandstones in the study area.


MEANDERING FLUVIAL SYSTEM
infilled oxbow
crevasse splay
back swamp
lake produced by subsidence
chute cut-off
levee
fining upward sequence
crevasse splay sandstone
coal

adapted from Gersib and McCabe, 1981

Figure 5. Depositional model for the upper Morien Group, with characteristic features labelled.

The alternating sequences are comprised of well vegetated levee, proximal crevasse splay, and near-levee flood plain deposits developed adjacent to the migrating channel system (Fig. 5). Finally, the thick mudstone facies assemblages are composed of distal flood plain, back-swamp, and lacustrine deposits (Fig. 5).

FURTHER WORK

Data collected during 1983 requires final synthesis, which includes:

1. Completion of stratigraphic sections and drill cores.
2. More detailed facies descriptions and enlargement of interpretations by reference to modern examples.
3. Drill core and coastal correlations.
4. Petrographic analysis of selected samples.

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PETROGRAPHY OF MINERALIZATION AT THE YAVA SANDSTONE-LEAD DEPOSIT, NOVA SCOTIA*

P. D. Vaillancourt and D. F. Sangster*****

ABSTRACT

The Yava sandstone-lead deposit in Cape Breton Island, Nova Scotia is in an Upper Carboniferous fluviatile sandstone above an unconformity over Lower Carboniferous sediments and a Devonian rhyolite basement. The lead occurs as disseminated galena filling the interstices of the sandstone grains.

Yava is on the southeast flank of the Salmon River sub-basin on the eastern platform border of the Fundy Basin. The deposit is comprised of 3 zones over a strike length of 3000 m which occur in paleovalleys, where sandstone is thickest, between intervening basement highs.

The sandstone at Yava is grey to green and massive to crossbedded. Quartz grains constitute between 70 and 85 per cent of the sandstone; the clay content varies from a strong kaolinite association with galena to a more chloritic association in the non-mineralized intervals. Galena is the dominant sulphide mineral but pyrite and minor sphalerite are present as well. The quartz grains have overgrowths of secondary silica. Pyrite occurs usually as amorphous masses forming a groundmass to isolated quartz grains. Sphalerite is mostly as inclusions in galena and in fractures of broken pyrite grains. Coal fragments, at the base of the sandstone, are also well mineralized with pyrite and galena being more abundant than in the sandstone. Sulphides occur as infillings to plant cells or along fractures in compacted coal.

INTRODUCTION

The Yava deposit in southeastern Cape Breton, Nova Scotia, is a former lead producer wherein galena is hosted in Upper Carboniferous fluviatile sandstone. The sandstone lies above an unconformity over Lower Carboniferous shales and a Devonian rhyolite basement. The Yava area is part of the Salmon River sub-basin. The Yava deposit is an outstanding example of a sandstone-lead occurrence of continental affiliation and presents a unique opportunity to contrast mineralization styles with other lead-zinc occurrences of similar type (Bjorlykke and Sangster, 1981). Within this framework, a petrographic study on the host sandstone as well as the coal and sulphide mineral occurrences at Yava was undertaken.

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*Also *in* Current Research, Part A, Geological Survey of Canada, Paper 84-1A, p.345-352, 1984 (with abstract in French).
Contribution to Canada-Nova Scotia Co-operative Mineral Program 1981-84.
Project carried by Geological Survey of Canada.

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The study of the host rock will not only include petrographic descriptions but will consider results from X-ray diffraction traces on clays from the sandstone. The nature of occurrence of galena, pyrite and sphalerite in sandstone as well as coal will also be reviewed with the objective of identifying common mineral associations and environments favourable to sandstone-lead occurrences.

REGIONAL GEOLOGY AND STRATIGRAPHY

The Yava deposit is located on the southeast flank of the Salmon River sub-basin on the eastern platform border of the Fundy Basin (Fig. 1).

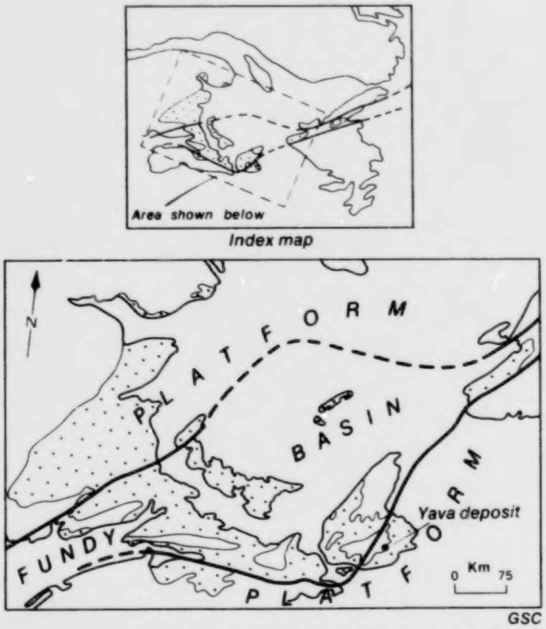


Figure 1. Location map showing position of the Yava deposit relative to Carboniferous sedimentary cover (shaded), pre-Carboniferous basement (unshaded), and major tectonic elements (from Hacquebard, 1972).

The Salmon River sub-basin forms an elongate, wedge-shaped syncline which gently plunges to the southwest and is truncated by faults along the northwestern and southwestern flanks. At Yava, lead-bearing rocks of the Canso Group of Namurian age lie unconformably on Viséan Windsor Group rocks and a basement composed of Cambrian granodiorite and a Devonian rhyolite porphyry (Barr et al., 1984).

Basement in the immediate Yava area consists of a red, quartz-feldspar porphyry which has been described as a rhyolite (Fig. 2). The overlying Windsor Group sediments have a maxmimum thickness of 150 m and consist mostly of limestone overlain by gypsiferous black shale and red to green mudstones. The overlying Namurian age rocks are up to 240 m thick and are dominated by fine- to medium-grained grey to green sandstone with thin shale interbeds and random coal fragments. The sandstone sequence is generally underlain by conglomerate up to 3 m thick and, in places, a calcareous breccia. The base of the sandstone is characterized by the presence of mineralized coal fragments.

GEOLOGY OF THE YAVA DEPOSIT

The Yava deposit is a monomineralic lead occurrence with proven reserves of 1.8 million t at 4.2% Pb (Bonham, 1982). Stratiform disseminated galena occurs as cement to the sandstone. The sandstone dips 15 degrees to the northwest.

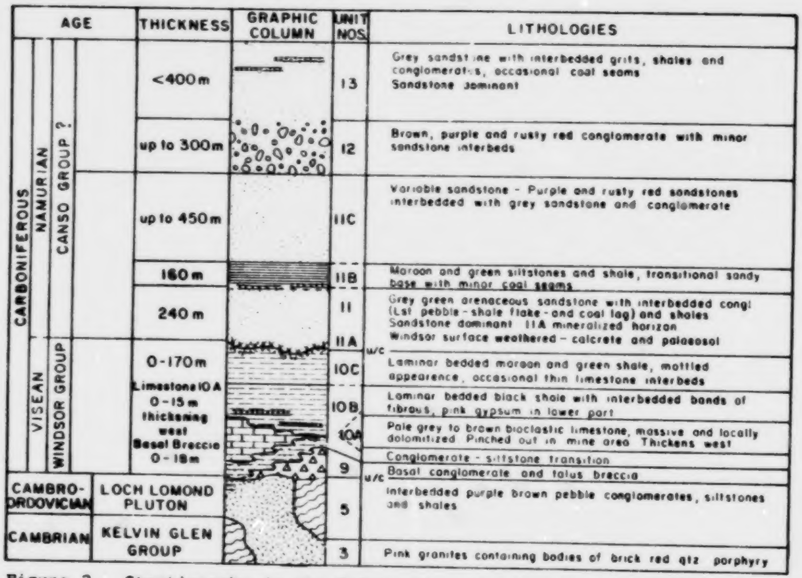
Yava is comprised of three zones: the west, central and east which occur within a strike length of 3000 m and extend down dip for 600 m (Bonham, 1982). The galena at Yava is related to the topography of the basement rocks, occurring in the paleovalleys, where sandstone is thickest, between intervening basement highs (Fig. 3).

PETROGRAPHY OF THE SANDSTONE

Sandstone is the major host for galena and makes up more than 90% of the Namurian strata at Yava. The sandstone is very homogeneous along strike and in vertical section. It is grey to green in colour, generally grey near the base of the section, where galena occurs, and green near the top of the section in unmineralized sandstone. It is mostly massive but may also have parallel or large-scale crossbeds to small-scale ripple crossbeds.

Grains are sub- to anhedral, semirounded and fine to coarse grained (0.1 to 2 mm). The lower galena bearing horizons appear to be slightly more coarse grained. The quartz grains in mineralized sandstone are characterized by secondary silica overgrowths which form straight edge boundaries with galena (Fig. 4).

Quartz grains comprise between 70% and 85% of the sandstone, with the matrix consisting mostly of clay minerals and microcrystalline quartz. Minor feldspar in the form of isolated microcline grains is also present and is distinctive by its weathered appearance with no well defined grain boundaries (Fig. 5). The borders of microcline grains are commonly replaced by carbonate or clay minerals. Muscovite also occurs, forming isolated large sinuous blades up to 3 mm long which overprint the matrix (Fig. 6). Minor gypsum is found near the base of the sandstone sequence. Preliminary petrographic and SEM investigations on polished thin sections from the west zone indicate that barite occurs with galena in the sandstone (Fig. 7); however, this association appears to be erratic and further work is needed to assess the importance of barite at Yava.



AGE			THICKNESS	GRAPHIC COLUMN	UNIT NOS.	LITHOLOGIES
CARBONIFEROUS	NAMURIAN	CANSO GROUP ?	<400m		13	Grey sandstone with interbedded grits, shales and conglomerates, occasional coal seams Sandstone dominant
			up to 300m		12	Brown, purple and rusty red conglomerate with minor sandstone interbeds
			up to 450m		11C	Variable sandstone - Purple and rusty red sandstones interbedded with grey sandstone and conglomerate
			160 m		11B	Maroon and green siltstones and shale, transitional sandy base with minor coal seams
			240 m		11	Grey green arenaceous sandstone with interbedded congl (Lst pebble - shale flake - and coal lag) and shales Sandstone dominant 11A mineralized horizon
					11A u/c	Windsor surface weathered - calcrete and palaeosol
	VISEAN	WINDSOR GROUP	0-170m		10C	Laminar bedded maroon and green shale, mottled appearence, occasional thin limestone interbeds
					10B	Laminar bedded black shale with interbedded bands of fibrous, pink gypsum in lower part
			Limestone 10A 0-15 m thickening west		10A	Pale grey to brown bioclastic limestone, massive and locally dolomitized Pinched out in mine area Thickens west
						Conglomerate - siltstone transition
			Basal Breccia 0-18m		9 u/c	Basal conglomerate and talus breccia
CAMBRO-ORDOVICIAN			LOCH LOMOND PLUTON		5	Interbedded purple brown pebble conglomerates, siltstones and shales
CAMBRIAN			KELVIN GLEN GROUP		3	Pink granites containing bodies of brick red qtz porphyry

Figure 2. Stratigraphy in the Salmon River sub-basin (from Bonham, 1982). Note that the Loch Lomond pluton is a composite pluton consisting of both Cambrian and Devonian phases (Barr et al.,1984).

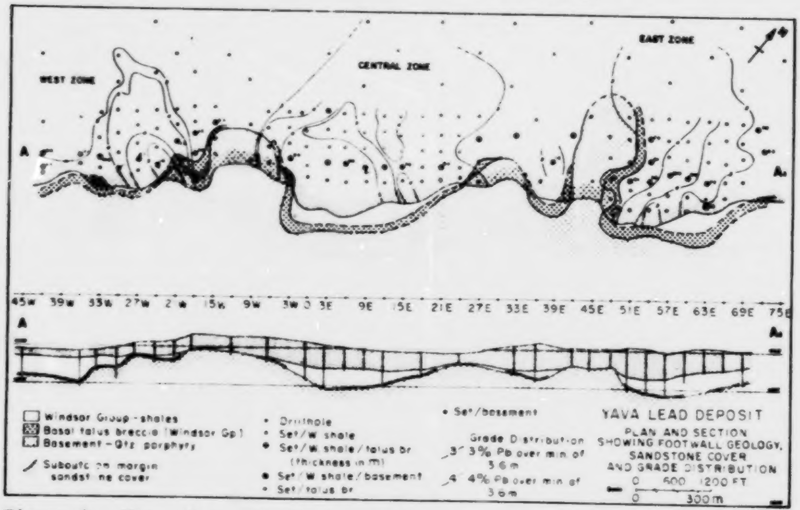

WEST ZONE
CENTRAL ZONE
EAST ZONE
A
A₁
45W 39W 33W 27W 21W 15W 9W 3W 0 3E 9E 15E 21E 27E 33E 39E 45E 51E 57E 63E 69E 75E
Windsor Group - shales
Basal talus breccia (Windsor Gp)
Basement - Qtz porphyry
Subcrop margin sandstone cover
Drillhole
Sst/W shale
Sst/W shale/talus br (thickness in m)
Sst/W shale/basement
Sst/talus br
Sst/basement
Grade Distribution
3 3% Pb over min of 3.6 m
4 4% Pb over min of 3.6 m
YAVA LEAD DEPOSIT
PLAN AND SECTION SHOWING FOOTWALL GEOLOGY, SANDSTONE COVER AND GRADE DISTRIBUTION
0 600 1200 FT
0 300 m

Figure 3. Map and longitudinal section of the Yava deposit (from Bonham, 1982).

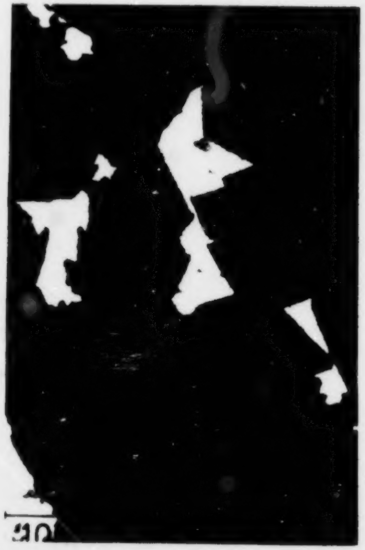


Figure 4. Straight-edge contacts between galena and silica overgrowths on detrital quartz grains. Bar scale is 100 µm.

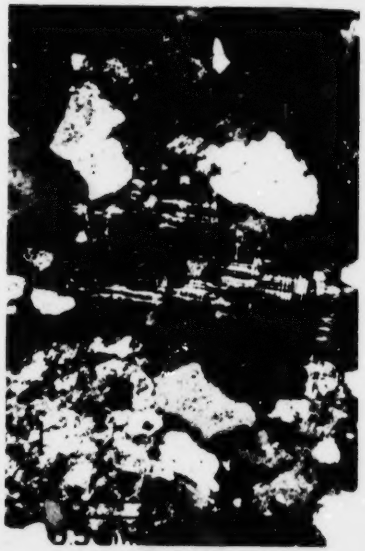


Figure 5. Weathered feldspar grain with carbonate and clay minerals at grain boundaries. Bar scale is 0.5 mm.

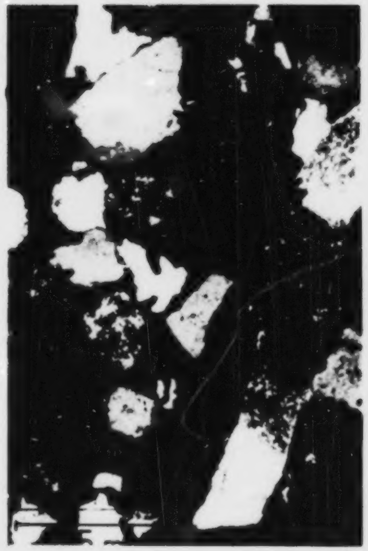


Figure 6. Large muscovite grain in host rock sandstone. Bar scale is 0.5 mm.

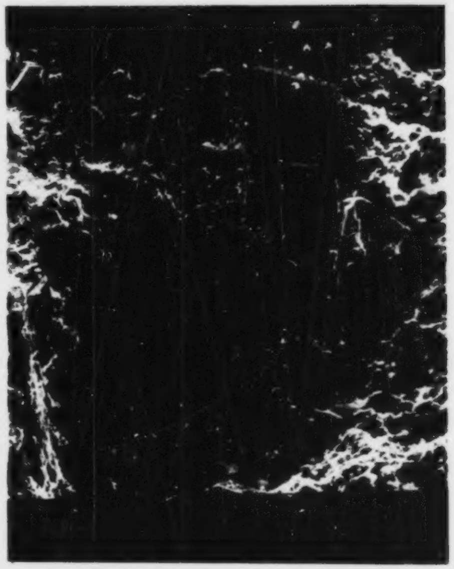


Figure 7. Scanning electon photomicrograph of barite (large grain occupying lower left quadrant) in contact with galena (upper centre). Irregular-textured mineral on right is kaolinite.

The presence of carbonate is also erratic but appears to be most prominent with coal where it forms a matrix to quartz and sulphide grains. Calcite is most noticeable under cathode ray luminescence where in some sections it appears as a matrix to detrital quartz grains. It is also present as a late stage occurrence in the interstices of quartz grains with secondary overgrowths.

CLAY MINERALOGY

The petrography of sandstone at Yava suggests that the sandstone high in the stratigraphic sequence has proportionately more green clay occupying pore space, and consequently is more chlorite rich than the grey galena-bearing sandstone at the base of the sequence. Research was initiated to investigate variations in clay mineralogy in mineralized versus unmineralized sandstone to detect compositional trends which could correlate with the abundance of galena (i.e. could the clay composition in sandstone be related to galena distribution?). As a result of this investigation, powders of clay material from sandstone were made and subsequently analyzed by X-ray diffractometer at the Geological Survey of Canada.

Scott (1980) determined from analyses that the clay content of the sandstones is between 75% and 90% kaolinite, with lesser amounts of illite, chlorite and montmorillonite. Scott, however, did not report any systematic compositional variations in clay compositions within the deposit. The analyses done for this study (Table 1) showed that, of 34 samples in 11 drillholes examined, 10 of the 11 holes demonstrated an increase in the kaolinite/chlorite ratio sympathetic with an increase in the lead content down the hole into mineralized sandstones (the eleventh hole was inconclusive due to an insufficient number of samples). Although the kaolinite/chlorite ratio changes were not quantitatively proportional to the variation in lead content, the changes generally correlated. The results suggest that kaolinite is the dominant clay mineral in the lower grey mineralized portion of the sandstone and that chlorite is associated with the unmineralized upper green sandstone. The X-ray diffraction traces also showed that illite increased proportionately to chlorite as a function of lead content; however, the results are not as consistent as the kaolinite/chlorite ratios, and further work is needed.

SULPHIDE PETROGRAPHY IN SANDSTONE

The sulphide mineral assemblage at Yava consists of galena, pyrite and sphalerite, with rare chalcopyrite. Galena is the dominant sulphide mineral and occurs mostly as disseminations in granular sandstone in the form of parallel bands, crossbeds, ripple sets, roll fronts or circular clusters. Other forms such as cusps, wisps and arrowheads are reported by Bonham (1982).

In thin section, galena occurs mostly as anhedral grains up to 0.4 mm but averages 0.2 mm. The grains, which partially to wholly fill pore spaces, are interstitial between clastic quartz grains and clay silicate matrix. Generally, galena appears as isolated grains but these may also coalesce to form an interconnected pattern within the sandstone. In areas of galena mineralization, quartz grains have secondary silica overgrowth features and galena typically forms straight edge boundaries

Table 1. Clay composition relative to depth of hole and Pb content

Sample	Kaolinite/Chlorite	%Pb
51-18	1.62	0.25
51-20	1.47	1.10
248-5	1.18	0.15
248-13	2.5	1.86
248-18	2.35	1.2
248-21	1.9	7
251-11	0.86	NM
251-26	1.25	<1.0
251-46	2.34	1.32
251-55	3.37	7.40
263-30	2.16	NM
263-41	2.75	1.83
263-51	2.79	7.41
268-8	1.67	NM
268-10	3.67	1.9
272-27	1.17	<2.0
272-29	3.08	13.58
283-16	4.68	1.44
283-22	5.56	6.52
283-26	2.70	1.0
303-15	1.02	NM
303-79	2.28	<1.0
303-88	3.31	5.0
352-140	1.15	NM
352-145	1.62	0.3
352-148	1.83	2.5
354-131	0.71	NM
354-146	1.24	1.8
354-152	4.62	4.52
363-53	0.95	NM
363-100	0.66	NM
363-141	1.31	<1.0
363-155	1.55	1.05
363-160	1.86	2.0

First column to the left is the hole number followed by the depth of the sample in metres. The middle column is the kaolinite/chlorite ratio measured by peaks of X-ray diffraction patterns; the peaks for the kaolinite (002) and chlorite (004) values are at approximately 25 degrees. The column to the right is the percentage of lead; NM denotes nonmineralized or very minor mineralization.

with the overgrowths. This form of mineralization is characterized by re-entrant angles between galena and the overgrowths. It is also common for galena to have irregular outlines where it is not bounded by quartz overgrowths (Fig. 8). Galena may contain inclusions of pyrite or sphalerite although, more commonly, the inclusions are small concentrations of clay material.

Pyrite is present in the sandstone sequence though it is much less abundant and more local than the galena. Pyrite is found most commonly as isolated patches in the sandstone and, in places, may be associated with galena. In the unmineralized sandstone above the galena bearing horizons, pyrite characteristically appears as clusters up to 2 cm in diameter in an otherwise barren green sandstone.

Petrographically, the mineralization style for pyrite is usually more intensive than galena; where present, pyrite acts as a cement supporting individual clastic grains appearing as islands (Fig. 9). The pyrite cement may occur as a homogeneous mass but usually has a fractured appearance with numerous disaggregated and broken grains, an occurrence most favourable for galena and sphalerite replacement.

Carbonate occurrence is also generally more abundant in sandstone near pyrite than galena; however, this occurrence is not ubiquitous. In general, calcite is more noticeable with pyrite near coal.

Sphalerite is not visible in hand specimen but, when seen microscopically, is usually associated with pyrite or galena and only rarely as individual grains. It is generally not abundant in the sandstone and does not represent more than 5% to 10% of total sulphide content. Within masses of galena, sphalerite occurs mostly as well defined anhedral inclusions from 0.05 mm to 0.2 mm (Fig. 10). Sphalerite is most abundant with galena where silica overgrowths on quartz grains are relatively insignificant and where galena forms irregular anhedral masses instead of straight edge contacts with quartz. Sphalerite also occurs as inclusions in pyrite but is more typical as a replacement along grain boundaries or margins of fractured pyrite grains.

SULPHIDE PETROGRAPHY IN COAL

The coal at Yava has special significance because it occurs in the form of randomly oriented tree fragments or logs around, and in which, there is abundant galena and pyrite (Fig. 11). Although mineralization in coal represents only 15% of total sulphide content at Yava (Bonham, 1982), it is nevertheless important because it contributes to the understanding of paragenesis and shows some important mineral relationships.

Sulphide minerals usually occur as amorphous patches or lenticular to boudin forms throughout the coal fragments, a feature probably attributable to compaction (Fig. 12). Pyrite, the most abundant sulphide mineral, followed by galena and sphalerite, appears as an early phase after which other sulphide minerals were emplaced.

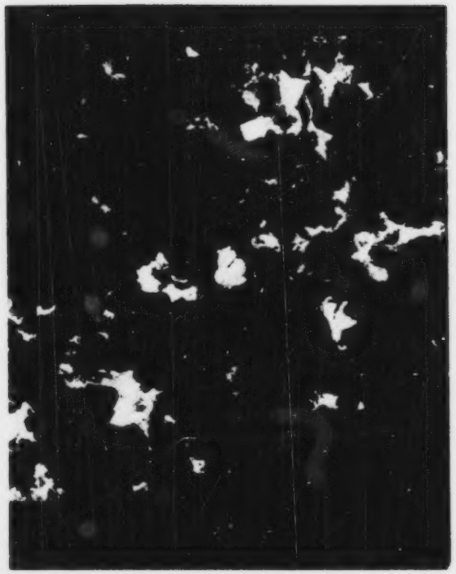


Figure 8. SEM photomicrograph (back scatter) of galena (light) in interstices of quartz grains (dark). Bright, square pyrite grain in upper centre.

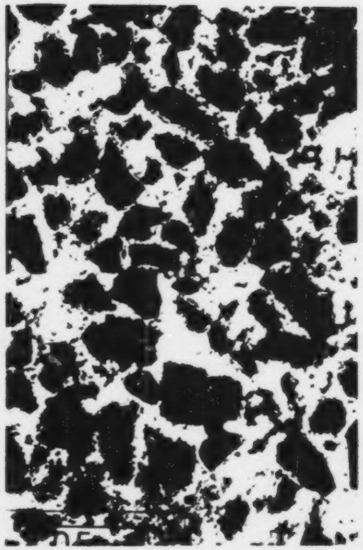


Figure 9. Detrital quartz grains (dark) completely cemented with pyrite (light). Bar scale is 0.5 mm.

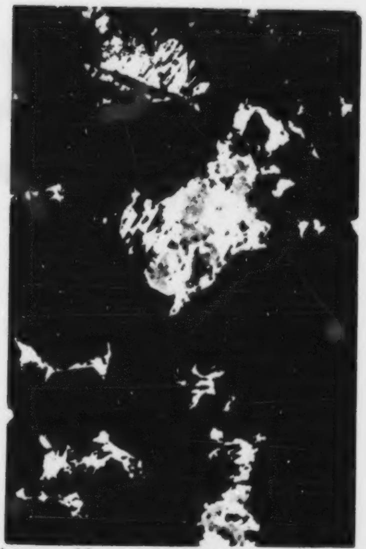


Figure 10. Irregular sphalerite inclusions (light grey) in galena (light). Bar scale (lower left) is 0.5 mm.

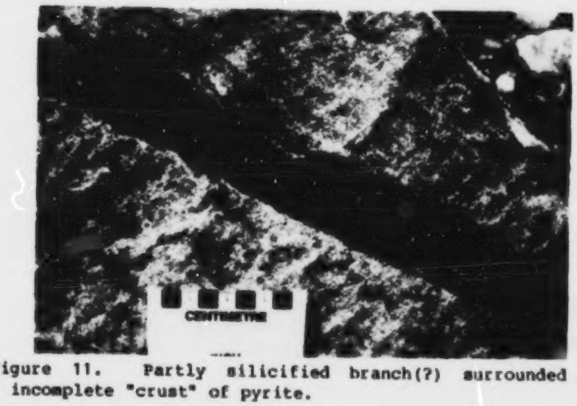


Figure 11. Partly silicified branch(?) surrounded by incomplete "crust" of pyrite.

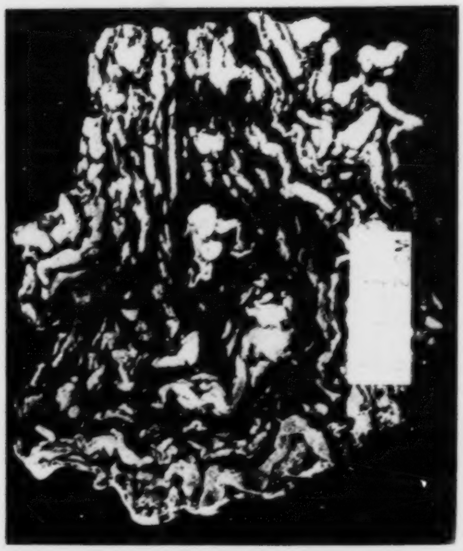


Figure 12. Pyrite- "coal" aggregate. Light-coloured irregular masses consist of pyrite replacing woody material in which the cellular structure is still preserved. Black areas are masses of high-reflectance "coal". Note galena-filled cleats in "coal".

Petrographically, mineralization textures range from open cellular fill to deformed or cataclastic and fractured. In the cellular fill mineralization, a network of near-circular cells are filled with a pyrite core surrounded by galena (Fig. 13). Cell cavities that are not sulphide-bearing are usually filled with silica. Where galena is not surrounding each cell, it occurs as thin veins running through the cell structure. The pyrite core may be in various stages of replacement by galena or, more commonly, sphalerite. In early stages of replacement, sphalerite occurs as thin bands 0.01 mm thick forming geometric growth zones within each cell in the pyrite groundmass (Fig. 14). The sphalerite growth bands are oriented independently of the cavity walls or the galena surrounding the cell and appear to have grown as a separate phase. Sphalerite also serves as a groundmass for isolated pyrite framboids, spherical clusters of pyrite grains from 0.01 to 0.05 mm in diameter. When replacement is in an advanced stage, the entire pyrite core may be replaced by sphalerite.

The more deformed coal has a different mineralization style, as the replacement of pyrite is more extensive. Coal material is crushed and fractured, leaving broken fragments and contorted remnants of coal and coal

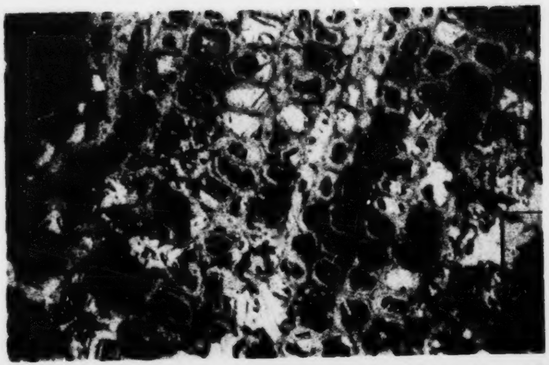


Figure 13. Pyrite (light grey) and sphalerite (dark) within wood cells; galena (white) replaces cell walls. Bar scale is 100 µm.

cells. Galena replacement is more pervasive; it forms envelopes around pyrite patches where the coal cells may only remain as faint outlines or are nonexistent. In the most deformed areas, there are no visible cell cavities. Galena is also widespread filling fractures and cleats in coal.

Sphalerite replacement varies greatly but appears to be mostly in the heavily fractured areas along the margins of galena-filled cleats and fractures (Fig. 15). Sphalerite also occurs in the outer areas of galena envelopes surrounding pyrite.

Not all coal is mineralized; in the upper nongalena bearing sandstone where coal is much less abundant, it is not silicified and is characterized by an absence of sulphide minerals.

PARAGENESIS

On the basis of ore mineralogy and relationships between grains, a paragenetic sequence would begin with early diagenetic pyrite in coal and locally reduced areas in the sandstone. Near coal, carbonate also appears to have precipitated early. Sphalerite in coal and sandstone formed in association with the pyrite as inclusions and, in places, as groundmass.

Silica overgrowths on quartz grains as well as the silicification of coal fragments followed the early pyrite and sphalerite and marked the beginning of the major mineralizing event. Galena shortly postdated the secondary overgrowths, occurring in the available pore space and in reaction with earlier sulphide stages. Barite, where present, occurred contemporaneously with galena. As a final phase, carbonate cement filled in some unoccupied pore spaces and sphalerite also occurred in reaction with earlier galena.

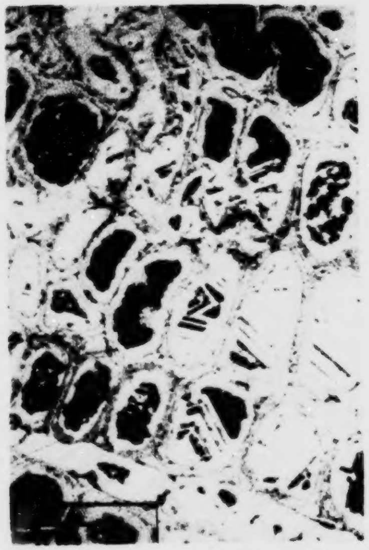


Figure 14. Pyrite (light grey) and sphalerite (dark) alternating in growth zones within wood cells. Cell walls replaced by galena. Bar scale is 100 µm.

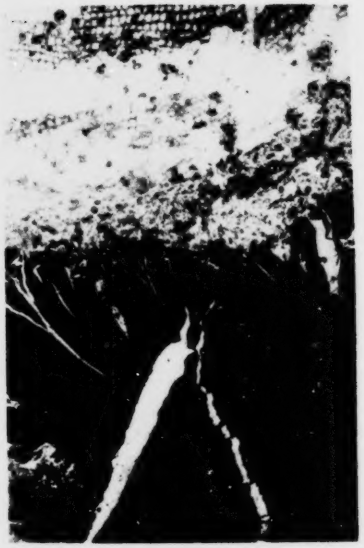


Figure 15. Galena-filled cleats in coal (dark). Note main mass of cellular-textured portion of photo is filled with pyrite; sphalerite fills cells near edge of woody material and galena replaces cell walls. Sphalerite also partially extends into galena-filled cleats. Bar scale is 0.5 mm.

CONCLUSIONS

The sandstone at Yava is remarkably uniform in composition, texture and mineralization style. Galena is the dominant sulphide mineral and is related to the distribution of secondary silica, the clay composition and grain size of the sandstone, as well as the occurrence of silicified coal. However, it is difficult to determine if the features related to galena occurrence are the result of diagenesis or were controls to mineralization.

For a better understanding of the mineralization process, future petrography must consider regional aspects of galena occurrence in the Salmon River sub-basin. Terra Nova, a deposit similar to Yava, has proportionately more sphalerite than Yava and is the only indication of metal zonation in the area. Beyond the deposit, the coal in unmineralized sandstone is not silicified; identifying a "silica line" between coals in mineralized and unmineralized sandstone would be helpful in delineating the extent of galena occurrence as well as determining the significance of silicification. Southwest of Yava, Windsor carbonates in contact with basement rocks contain galena, and the study of its occurrence in these rocks would also contribute to the understanding of mineralization processes in the Salmon River sub-basin. Finally, it would be instructive to expand the study of clay minerals beyond the immediate Yava area to assess the importance of clay composition in sandstone with respect to galena occurrence.

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MARGINAL MOLASSIC BASIN ONLAP AND MINERAL DEPOSITS, LOCH LOMOND BASIN, CAPE BRETON ISLAND*

R. C. Boehner

The Loch Lomond Basin is a small structural basin that presently has the form of a northeasterly trending half graben. It is fault bound to the northwest and contains up to 800+ m of Viséan to Namurian age rocks. It is bordered on the northwest by Hadrynian Fourchu Group volcanic-sedimentary rocks and plutonic rocks of the East Bay Hills. The major unconformable contact to the southwest is with similar rocks of the East Bay Hills (largely the Loch Lomond pluton).

The Loch Lomond Basin contains a mixed Carboniferous succession dominated by marginal continental alluvial-fluvial and marine evaporite-carbonate sediments representing molassic deposition. Major rock packages recognized are comparable (with a few exceptions) with those in other parts of Nova Scotia and include in ascending order: Windsor Group evaporite, fine to coarse redbeds and marine carbonate (middle and upper parts only), Enon, Loch Lomond and Uist Formations (up to 350 m); fine grained Canso Group (up to 200 m); and upper Canso Group (dominantly grey sandstone up to 250+ m).

Progressive onlap and overstep of stratigraphic packages with accompanying facies changes are well documented both parallel and perpendicular to the strike of the Loch Lomond Basin. Similar changes are also present in the Salmon River-Glengarry Basin. Details of these features remain to be fully documented (1983).

Paleotopography and tectonism greatly influenced sedimentation in the Loch Lomond Basin, especially the early stratigraphic units. Their importance decreased with time as erosion and deposition of onlapping strata buried the basement topography. The stratigraphic section to the top of the fine grained Canso Group displays general fining upward and basinward trends. Coarse fanglomerate facies occur as a marginal facies of the Windsor Group at all stratigraphic levels.

The numerous mineral occurrences in the area are concluded to be closely related to paleogeography (topography), tectonics and sedimentation history (especially unconformities and stratigraphic onlap-overstep). Progressive onlap-overstep is inferred to be the principal factor which produced conditions suitable for the concentration and entrapping of contact oriented and stratabound celestite, barite, Pb, Zn, Cu, Mn and abundant, but economically unattractive Fe.

Base metals ± minor celestite ± Fe ± Mn occurrences are contact oriented and localized at or near unconformity pinchouts at all stratigraphic levels. Secondary redistribution of celestite ± base metals ± Fe (supergene?) is inferred to have occurred in karst related hydration zones. Barite and celestite ± Pb ± Zn ± Fe are dominantly stratabound, stratified to nodular deposits (within marine carbonate, gypsum-anhydrite, red siltstone-sandstone) and may represent diagenetic replacement during or soon after Windsor Group sedimentation.

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*Presented at the 1983 Atlantic Geoscience Society Symposium: The Origin, History and Potential of Sedimentary Basins in Eastern and Offshore Canada; Fredericton, New Brunswick, January 28 and 29, 1983.

UPPER CARBONIFEROUS STRATA OF THE EAST HALF OF THE TATAMAGOUCHE SYNCLINE, CUMBERLAND BASIN, NOVA SCOTIA[*]

R. J. Ryan[**]

ABSTRACT

The Upper Carboniferous strata of the eastern Tatamagouche Syncline area consist of fining upward cycles of conglomerates to mudstones. The strata can be divided into seven map units, in ascending order: Millsville Formation, Boss Point Formation, Cumberland Group, Pictou Group grey beds, Pictou Group lower red beds, Pictou Group middle red beds, and the Pictou Group upper red beds. Regularly interbedded lacustrine limestone marker beds facilitate definition and correlation of the upper units.

Alluvial fans developed in the south from pre-Carboniferous rocks in the present day Cobequid Highlands. Towards the north, sand and mud were deposited along low sinuosity, anastomosing rivers. Strongly unimodal paleocurrent measurements indicate flow to the north-northwest.

Copper, uranium and recently discovered lead occurrences are associated almost exclusively with carbon-rich channel lag conglomerate and sandstone.

INTRODUCTION

The eastern half of the Tatamagouche Syncline within the Carboniferous Cumberland Basin of northern Nova Scotia was the subject of geological investigations during the 1983 field season. The rocks exposed within the study area are the Riversdale, Cumberland and the Pictou groups of continental origin (Fig. 1). These Upper Carboniferous rocks are folded into a gently plunging syncline trending northeast, and consist of red and grey conglomerates, sandstones and mudstones with minor limestones, totalling approximately 3400 m in thickness. The rocks form a series of fining-upward cycles, with a thickness for each cycle of approximately 200 m. The evaluation of the stratigraphy was greatly aided by the availability of approximately 80 diamond-drill hole cores totalling about 40 000 feet.

STRATIGRAPHY

The Upper Carboniferous strata of the Tatamagouche Syncline can be divided into seven mappable units (Figs. 2 and 3).

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[*] Also *in* Current Research, Part A, Geological Survey of Canada, Paper 84-1A, p. 473-476, 1984 (with abstract in French). Contribution to Canada-Nova Scotia Co-operative Mineral Program 1981-84. Project carried by Geological Survey of Canada and Nova Scotia Department of Mines and Energy.

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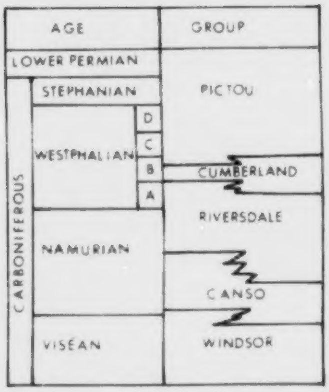
AGE
GROUP
LOWER PERMIAN
STEPHANIAN
PICTOU
D
C
WESTPHALIAN
B
CUMBERLAND
A
CARBONIFEROUS
RIVERSDALE
NAMURIAN
CANSO
VISEAN
WINDSOR

Figure 1. Generalized Carboniferous stratigraphy in the eastern Tatamagouche Syncline, Cumberland Basin, Nova Scotia.

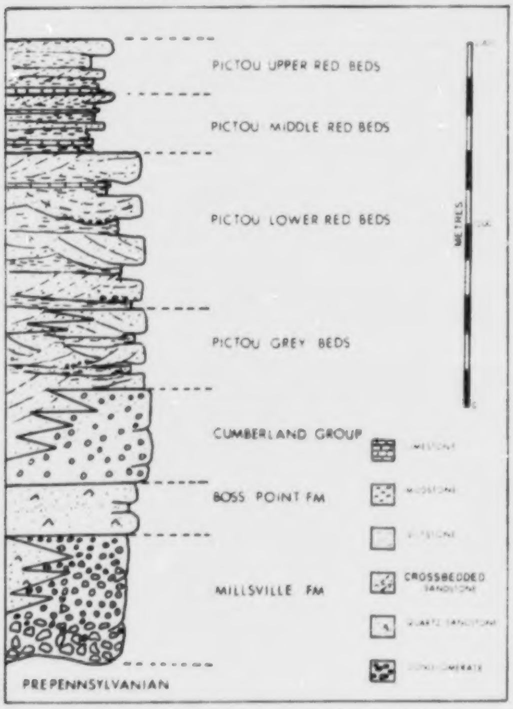
PICTOU UPPER RED BEDS
PICTOU MIDDLE RED BEDS
PICTOU LOWER RED BEDS
PICTOU GREY BEDS
CUMBERLAND GROUP
BOSS POINT FM
MILLSVILLE FM
PREPENNSYLVANIAN
METRES
LIMESTONE
MUDSTONE
SILTSTONE
CROSSBEDDED SANDSTONE
QUARTZ SANDSTONE
CONGLOMERATE

Figure 2. Stratigraphic column of Upper Carboniferous strata, eastern Tatamagouche Syncline.

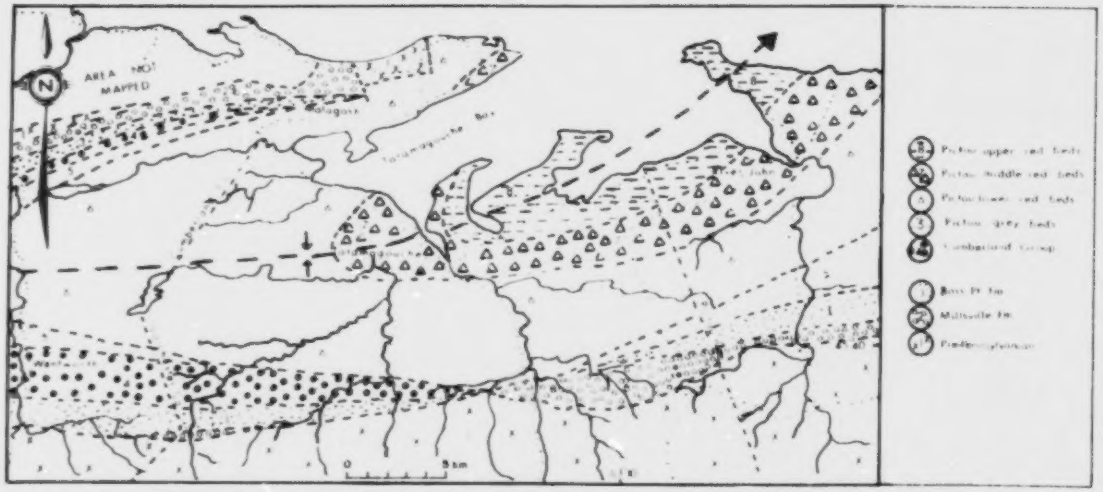
N
AREA NOT MAPPED
Malagash
Tatamagouche Bay
River John
Tatamagouche
0
5km
Pictou upper red beds
Pictou middle red beds
Pictou lower red beds
Pictou grey beds
Cumberland Group
Boss Pt Fm
Millsville Fm

Figure 3. Generalized geological map of Upper Carboniferous rocks, eastern Tatamagouche Syncline.

RIVERSDALE GROUP

Millsville Formation

The term Millsville Formation was introduced by Bell (1926) to refer to exposures of reddish-brown conglomerates located in the vicinity of Millsville, Pictou County, Nova Scotia. The Millsville Formation in the eastern part of the Tatamagouche Syncline is a unit comprised of dominantly red, although locally grey, boulder to pebble conglomerates and minor sandstones. The conglomerates are rarely crossbedded, but do possess poorly developed imbrication. The formation varies from 150 to 700 m in thickness. Age: Namurian.

Boss Point Formation

The Boss Point Formation was defined by Bell (1914) to include the sandstones, siltstones, and shales of Westphalian A age exposed at Boss Point, Cumberland County, Nova Scotia. In the Tatamagouche area the formation consists of grey to brown, coarse- to fine-grained quartz sandstones, minor arkosic sandstones, and siltstones. The sandstones are usually crossbedded and are variably carbonaceous. The formation varies from 150 to 700 m in thickness within the mapped area. Age: Westphalian A.

CUMBERLAND GROUP

Cumberland Coarse Facies

This unit consists of red polymictic cobble to pebble conglomerate which may contain clasts of Carboniferous sandstones. Trough crossbedding is common, and the conglomerates have moderate to good imbrication. This formation varies from being absent on the southeast limb, to a thickness of 600 m on the northwest limb of the Tatamagouche Syncline. Age: Westphalian B.

PICTOU GROUP

The name Pictou Group was proposed by Bell (1926). He applied the term to the reddish-brown sandstones, mudstones, and conglomerates exposed on River John, Pictou County, Nova Scotia.

Pictou Grey Beds

These beds are made up of grey arkosic sandstones, siltstones, and mudstones. The sand to silt + mud ratio is approximately 3:1. The sandstone units are trough crossbedded and may have a calcareous mud-chip conglomerate at their base. The rocks are variably carbonaceous with some carbon-rich channel lags present. The siltstones and mudstones are ripple marked and locally are bioturbated. The thickness varies from 100 to 400 m. Age: Westphalian B-C.

Pictou Lower Red Beds

These beds are usually red, and the unit is made up of calcareous mud-chip conglomerates, arkosic sandstones, crosslaminated siltstones and bioturbated mudstones. The sand to silt + mud ratio is approximately 2:1. The sandstones and conglomerates are trough crossbedded and are variably carbonaceous. Locally calcretes are developed, which contribute the calcareous material to the mud-chip conglomerates. This unit is 800 to 900 m thick. Age: Westphalian C-D.

Pictou Middle Red Beds

This unit consists of predominantly red sandstones, conglomerates, siltstones and mudstones. The sand to silt + mud ratio is approximately 1:2. The sandstones and conglomerates are trough crossbedded and variably carbonaceous. The siltstone beds have lunate ripples with localized calcrete development. A few thin, but laterally extensive, limestone beds, probably representing deposition in large lakes which covered the central parts of the syncline, facilitate correlation. The unit is about 310 m thick. Age: Wesphalian D to Stephanian.

Pictou Upper Red Beds

This unit consists of red and locally grey conglomerates, arkoses and sandstones, siltstones and mudstones. The sand to silt + mud ratio is 1:3 to 1:4. The sandstones and conglomerates are trough crossbedded. The finer grained sedimentary rocks are lunate ripple marked and locally highly bioturbated. Mud-filled channel plugs are common. Thin, laterally extensive lacustrine limestones and calcretes occur throughout the unit. Some carbon-rich channel lag sandstones are present within the thick channel sandstone sequences. The unit is approximately 330 m thick. Age: Stephanian to Early Permian.

SEDIMENTOLOGY AND PALEOCURRENT STUDIES

Over 300 paleocurrent measurements were recorded during the 1983 field season. Ripple marks, parting lineations, crossbed truncation ridges, preferred plant fragment orientations, flute marks, tool marks, pebble imbrications and crossbedding were all used in the paleocurrent study. The trough crossbedding yielded the most conistent of the paleocurrent determinations and therefore, it is these data that are presented in Figure 4 of this report.

The paleocurrent data exhibit a strongly unimodal distribution with the modal trend of north-northwest, 340°. The low variance of the paleocurrent data indicates that deposition, for the most part, occurred in a low-sinuosity flow. Only the Pictou upper red bed unit exhibits significant variability in paleocurrent directions. The north-northwest paleocurrent direction persisted from the Namurian through to the Early Permian.

Field mapping, which confirmed the presence of numerous channels, together with low sand to silt ratios and unimodal paleocurrent data, suggest that during most of the Late Carboniferous the dominant depositional environment consisted of low-sinuosity streams whose configuration would have been that of anastomosing streams.

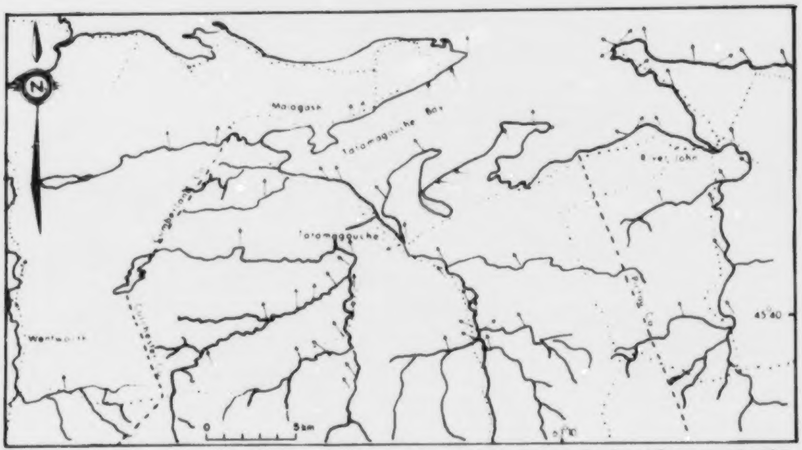

Figure 4. Crossbed paleocurrent trends within Upper Carboniferous strata, eastern Tatamagouche Syncline.

The Boss Point Formation exhibits slight variations (up to about 30 degrees) of the paleocurrent directions, which suggest a more typical meandering stream environment of deposition for the quartz sandstones of this unit.

The Millsville Formation and the coarse facies of the Cumberland Group represent alluvial fans, the Millsville being a proximal fan flanking the Cobequid Highlands to the south, and the Cumberland conglomerates representing a mid to distal fan produced by an uplift of the Cobequid Highlands at the end of the Westphalian A.

ECONOMIC GEOLOGY

There are 32 significant metallic mineral occurrences within the eastern half of the Tatamagouche Syncline (Fig. 5). The copper occurrences are the most numerous, and several of these have associated uranium mineralization (McNabb, 1977; MacDonald, 1978). Several new occurrences were found during this study, most of which were copper occurrences. One lead occurrence was discovered in boulders at Skinners Cove (Fig. 5). Although no geochemical results were available at the time of publication, it is strongly suspected that silver values are associated with the galena. The galena is associated with siderite and plant debris. The lithology of the boulders is consistent with that of the basal channel lag sandstones of the Pictou middle red beds exposed along the cliff above the beach where the boulders were found.

Copper usually occurs as malachite, nodules of chalcocite or as chalcocite replacing carbon plant material.

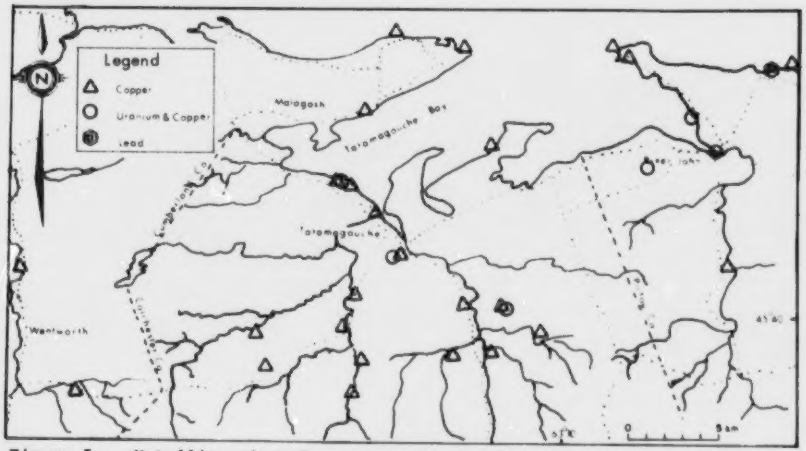

Figure 5. Metallic mineral ocurrences in Upper Carboniferous strata, eastern Tatamagouche Syncline.

Uranium occurrences can also occur with little or no associated copper mineralization (McNabb, 1977). The uranium mineralization is also very closely associated with the presence of carbon. The uranium seen as occurrences, represents the uranium bound with the carbon, left behind by the migrating uranium-bearing solutions.

Dunsmore (1977) suggested that the mineralization usually occurred near the base of fining-upward cycles in the Tatamagouche area. Almost all of the mineralization, copper, lead, and uranium, is associated with the carbon-rich channel lag sandstones which usually, although not everywhere, occur near the base of the channel sandstone units. Because the lag sandstones are part of the overall channel sequence, it is necessary to follow such beds down channel, and not down dip, in order to delineate potential mineralized zones. It is therefore vital that paleocurrent data be incorporated into any exploration model for the Tatamagouche Syncline area.

ACKNOWLEDGMENTS

The author gratefully acknowledges the assistance of T. Johnson in the field and the valuable discussions with B. McNabb of Lacana and J. O'Sullivan of Esso Minerals. The author would also like to acknowledge the contributions to this paper by H. W. van de Poll.

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WINDSOR GROUP SALT AND POTASH IN NOVA SCOTIA, CANADA*

R. C. Boehner

ABSTRACT

The Windsor Group (Viséan) is a regionally widespread unit up to 1000 m thick. It is dominated by subaqueous and diagenetic marine evaporites including halite, anhydrite, gypsum and potash with subordinate interstratified redbeds and marine carbonates. These rocks display a wide range of structural and stratigraphic complexities within the Carboniferous depositional and tectonic setting. Carboniferous basins in Nova Scotia are part of the complex Magdalen (Fundy) Basin system developed in the Acadian Orogen in Atlantic Canada. They contain up to 7000 m of pull-apart basin molassic sediments with minor, but economically important, marine evaporites of the Windsor Group. Deformation varies from negligible in the relatively stable platform blocks characterized by thin sediment accumulation to substantial in the fragmented basinal areas involving Hercynian strike slip, thrust and normal faulting, gravity sliding, evaporite diapirism and folding of the thick sedimentary fill.

Until recently, the distribution and geology of the evaporites, especially salt and potash, have been poorly understood because of limited data. Recent drilling has established that salt is present throughout the Windsor Group section. The principal salt unit including potash (sylvite and carnallite) is located in a major carbonate-sulphate-chloride cycle at the base of the Windsor Group. Thinner and younger salt beds with minor potash are locally present in association with anhydrite and marine carbonate in numerous saline "minicycles".

The large salt resources of Nova Scotia, together with geographic location and the presence of potash, are important factors which may encourage future development of mining and chemical industries and underground storage facilities.

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*Presented at the Sixth International Symposium on Salt; Toronto, Ontario, May 25, 1983.

STRATIGRAPHIC DRILLHOLE NSDME GLEN ROAD 83-1, WESTERN PART OF THE ANTIGONISH BASIN, ANTIGONISH COUNTY, NOVA SCOTIA

R. C. Boehner

INTRODUCTION

Diamond-drill hole NSDME Glen Road 83-1 was drilled by the Nova Scotia Department of Mines and Energy in the western part of the Antigonish Basin (Fig. 1) beginning late in August and finishing early in October 1983. The purpose of this special project was to provide stratigraphic and structural information on the Middle to Late Viséan Windsor Group. More specifically, it was hoped that the drillhole would (1) provide type or reference sections for poorly known formations in an area with no subsurface data, (2) provide information on the existence and significance of the Antigonish Thrust Fault, and (3) provide information on the presence and extent of base metal, salt and potash deposits, occurrences known to be present in the area.

The hole was continuously cored from the top to the total depth of 846.7 m to gain the maximum information possible (Fig. 2). In addition, downhole geophysical logging (Gamma Ray and Density) was conducted through the drillstring by the Nova Scotia Research Foundation Corporation from surface to 837.5 m. Core recovery through the entire section approached 100 per cent and was excellent considering the fractured nature of the rock. Deviation in the drillhole was significant, with a maximum of 9° measured at 770 m (Fig. 2). This should be considered in any detailed use of the stratigraphic data.

The hole was drilled using a Departmental Longyear 44 with core sizes and casing as indicated in Figure 2. The drill fluid was fresh water from surface to 580 m and then salt saturated brine to total depth at 846.7 m. An overflow of ground water was encountered from surface to 30 m depth (in the E_1). Upon abandonment all intermediate casing and drill rods were removed, the hole was cemented from 500 m to surface, and the 6 inch surface casing cut off 1.3 m below ground level.

GENERAL GEOLOGY

The geology of the Antigonish Basin has been described in reports and maps by Boehner (1980) and Boehner and Giles (1982). NSDME Glen Road 83-1 was collared in the E_1 Limestone at the top of the Hood Island Formation of the Windsor Group (Fig. 3). This unit is exposed near the drill site in a small quarry situated on the southwestern limb of the Glen Road Syncline (Fig. 1). The drillhole intersected Hood Island Formation (Upper Windsor) to a depth of 584.4 m. Carbonate members in this section are correlated with the E_1 to B_3 Limestones as outlined by Giles and Boehner (1982) (Fig. 3). The thickness and general lithology are similar to the type section of the Hood Island Formation on Port Hood Island. The base of both Hood Island Formation sections is apparently incomplete due to faulting.

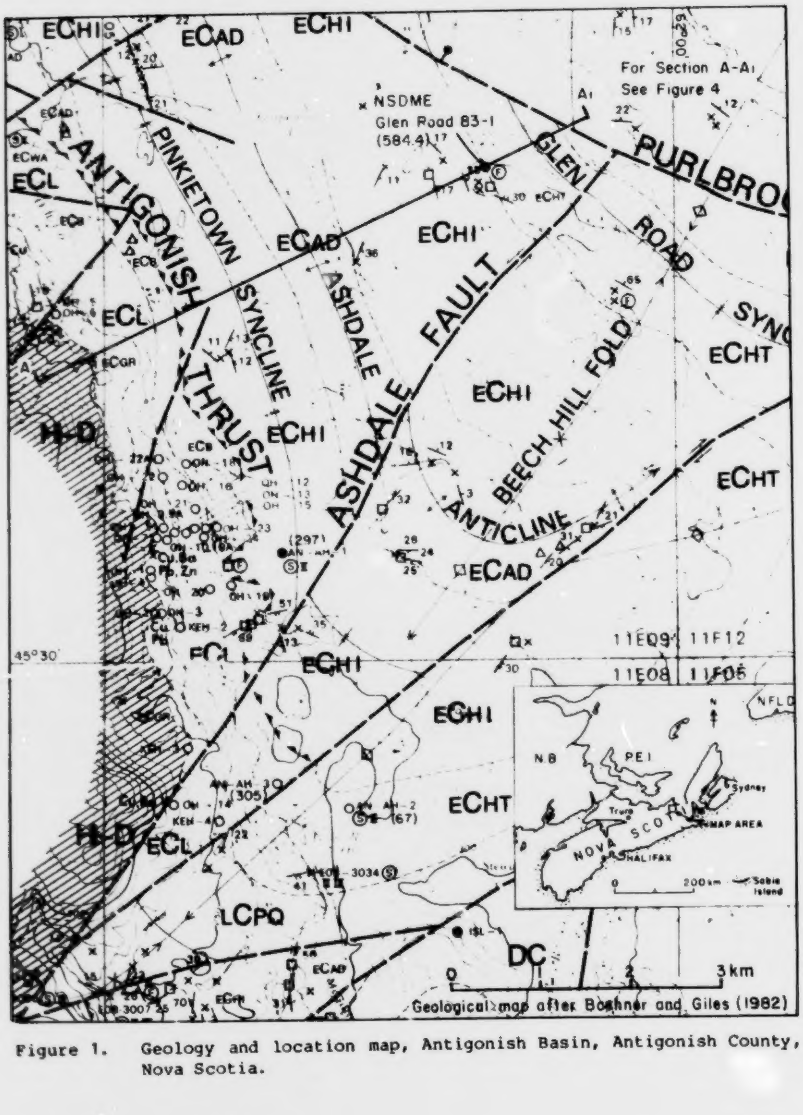

ECHI
ECAD
ECHI
NSDME
Glen Road 83-1
(584.4)
For Section A-A1
See Figure 4
A1
PURLBRO
GLEN
ROAD
SYNC
ANTIGONISH
PINKIETOWN
SYNCLINE
THRUST
ASHDALE
ASHDALE
FAULT
BEECH HILL FOLD
ANTICLINE
ECL
ECHI
ECHT
ECHT
ECAD
H-D
H-D
ECL
LCPQ
DC
ECHI
ECHT
45°30'
11E09
11F12
11E08
11F05
N.B
P.E.I
NOVA SCOTIA
Sydney
Truro
MAP AREA
HALIFAX
NFLD
N
0
200km
Sable Island
0
1
2
3km
Geological map after Boehner and Giles (1982)

Figure 1. Geology and location map, Antigonish Basin, Antigonish County, Nova Scotia.

LEGEND

SYSTEM
SUBSYSTEM
SERIES
STAGES

PALAEOZOIC
CARBONIFEROUS
SILESIAN
DINANTIAN
WESTPHALIAN
NAMURIAN
VISEAN
TOURNAISIAN
BRIGANTIAN
WARNANTIAN
ASBIAN
HOLKERIAN
LIVIEN
ARUNDIAN
MOLINIACIEN
CHADIAN
IVORIEN
HASTARIEN
BRITISH ISLES
BELGIUM
HADRYNIAN
CAMB
ORD
SIL
DEVONIAN

RIVERSDALE GROUP

CPH *PORT HOOD FORMATION* grey and brown sandstone and conglomerate

CANSO GROUP

CPO *POMQUET FORMATION* red and minor grey - green siltstone and sandstone

ECHT *HASTINGS FORMATION* grey shale and siltstone with red shale and minor limestone

WINDSOR GROUP

ECH *HOOD ISLAND FORMATION* red siltstone and sandstone with intercalated marine limestone and dolostone and minor gypsum; rhythmic alternation of these rock units is characteristic

disconformity

ADDINGTON FORMATION (ECAD) red siltstone, with gypsum and anhydrite and thin carbonate beds; rhythmic alternation of these rock units is typical

ECWA ECAD *WALLACE BROOK FORMATION* (ECWA) limestone, with minor dolostone, intercalated with red siltstone and sandstone; includes gypsum and anhydrite in the subsurface

ECL *LAKEVALE FORMATION* (ECL) grey and reddish-brown polymictic conglomerate and paraconglomerate with gypsum and anhydrite in the subsurface; minor carbonate rocks are intercalated in some sections

disconformity and/or thrust fault

ECHH *HARTSHORN FORMATION* (ECH) halite, grey and white with thin interbeds of anhydrite and grey-green siltstone; minor sylvite and carnallite; known only in the subsurface

ECB *BRIDGEVILLE FORMATION* (ECB) anhydrite and gypsum with limestone and dolomitic limestone in variable proportion as interbeds

ECGR *GAYS RIVER FORMATION* (ECGR) limestone, minor dolostone, thinly bedded, argillaceous, in part peloidal; locally thickly bedded and highly fossiliferous in mound-shaped deposits resting upon pre-Carboniferous rocks

ECM *MACUMBER FORMATION* (ECM) limestone in part dolomitic, laminated and/or banded, peloidal, sparsely fossiliferous, includes limestone breccias of complex origin

HORTON GROUP

ECWB *WILKIE BROOK FORMATION* conglomerate, sandstone and shale with minor algal and oolitic limestone

angular unconformity

DC Undivided *DEVONO-CARBONIFEROUS ROCKS* grey and reddish-brown polymictic conglomerate, grey and pale red feldspathic sandstone, red shale, and grey shale, in part highly bituminous; thin beds of fresh-water limestone occur in association with grey shales, and volcanic rocks are known in the subsurface south of Stewart Lake

angular unconformity

▨ H-D Undivided *HADRYNIAN TO DEVONIAN ROCKS* shale, slate, greywacke, basalt and rhyolite, variably deformed and metamorphosed; may include rocks previously assigned to the Knoydart Formation, Arisaig Group, Browns Mountain Group and Georgeville Group

▨ ᴰCg ▨ Cg *PLUTONIC ROCKS* Antigonish Harbour and James River Plutons (ᴰCg) granite and microgranite; Ohio River Pluton (Cg) granitoid rocks

SYMBOLS

Rock outcrop limestone, dolostone, commonly fossiliferous	□
gypsum, anhydrite	△
terrigenous sedimentary and volcanic rocks	×
granitoid rocks	○
areas with continuous outcrop	
Bedding horizontal, inclined, vertical, overturned, tops unknown	
Geological boundary, approximate, dotted beneath major bodies of water	
Fault, approximate, dotted beneath major bodies of water	— —·····
relative fault movement, wrench fault	
symbol on downthrown side	
Thrust fault, barbs point down-dip	
Anticline and syncline	
Antiform and synform	
Anticline and syncline, overturned	
Fossil locality	
Spore locality (zonation after Utting, 1978, 1980)	
Diamond-drill hole	●
Mine or quarry, ls - limestone	ls
Mineral occurrence or prospect Pb - lead, Zn - zinc, Cu - copper, Ba - barite, Fl - fluorite	□ Pb
Rb - Sr whole rock isochron age ^{87}Rb $= 1.42 \times 10^{-11}$ yr	
Drillhole intersecting salt, number (depth to salt in metres)	●
Drillhole, number (total depth in metres)	○

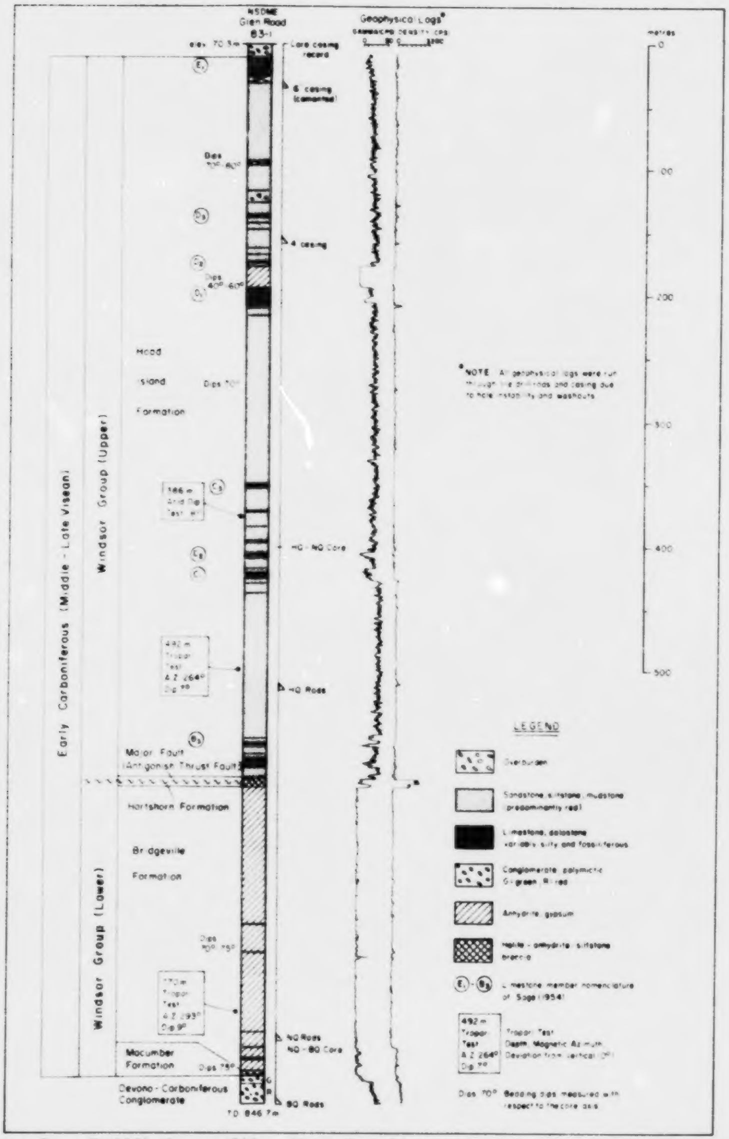

NSDME
Glen Road
83-1
elev. 70.3 m
Core casing record
6 casing (cemented)
4 casing
HQ - NQ Core
HQ Rods
NQ Rods
NQ - BQ Core
BQ Rods
TD 846.7 m
Geophysical Logs*
metres
0
100
200
300
400
500
*NOTE: All geophysical logs were run through the drill rods and casing due to hole instability and washouts
Early Carboniferous (Middle - Late Visean)
Windsor Group (Upper)
Windsor Group (Lower)
Hood Island Formation
Dips 70°-80°
Dips 40°-60°
Dips 70°
186 m Acid Dip Test
492 m Tropari Test A.Z. 264° Dip 7°
Major Fault (Antigonish Thrust Fault)
Hartshorn Formation
Bridgeville Formation
Macumber Formation
Dips 75°
Devono - Carboniferous Conglomerate
LEGEND
Overburden
Sandstone, siltstone, mudstone (predominantly red)
Limestone, dolostone variably silty and fossiliferous
Conglomerate, polymictic G: green, R: red
Anhydrite, gypsum
Halite - anhydrite, siltstone breccia
Limestone member nomenclature of Sage (1954)
Tropari Test
Depth, Magnetic Azimuth
Deviation from vertical (7°)
Dips 70° Bedding dips measured with respect to the core axis

Figure 2. Drillhole profile, Nova Scotia Department of Mines and Energy, Glen Road 83-1, Antigonish Basin.

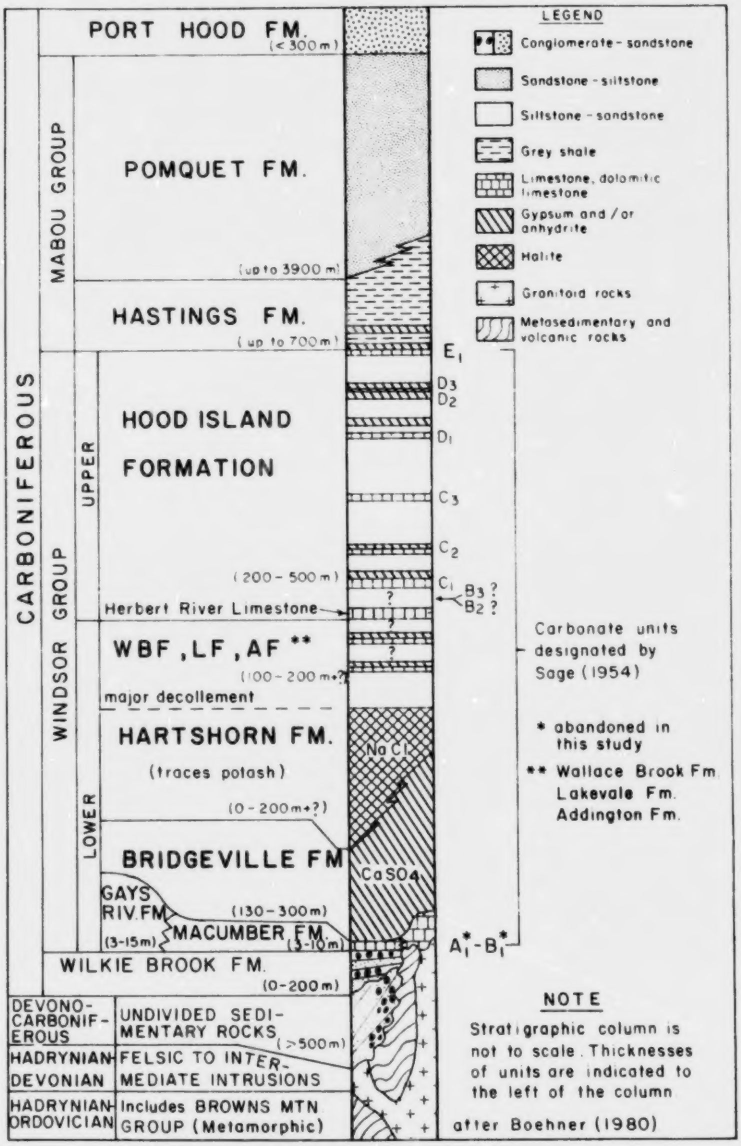

PORT HOOD FM.
(< 300 m)
MABOU GROUP
POMQUET FM.
(up to 3900 m)
HASTINGS FM.
(up to 700 m)
CARBONIFEROUS
WINDSOR GROUP
UPPER
HOOD ISLAND FORMATION
(200 - 500 m)
Herbert River Limestone
WBF, LF, AF **
(100 - 200 m+?)
major decollement
LOWER
HARTSHORN FM.
(traces potash)
(0 - 200m+?)
BRIDGEVILLE FM
(130 - 300m)
GAYS RIV. FM
(3-15m)
MACUMBER FM.
(3-10m)
WILKIE BROOK FM.
(0-200m)
DEVONO-CARBONIFEROUS
UNDIVIDED SEDIMENTARY ROCKS
(>500m)
HADRYNIAN-DEVONIAN
FELSIC TO INTERMEDIATE INTRUSIONS
HADRYNIAN-ORDOVICIAN
Includes BROWNS MTN GROUP (Metamorphic)
NaCl
CaSO4
?
E1
D3
D2
D1
C3
C2
C1
B3 ?
B2 ?
A1* - B1*
LEGEND
Conglomerate - sandstone
Sandstone - siltstone
Siltstone - sandstone
Grey shale
Limestone, dolomitic limestone
Gypsum and / or anhydrite
Halite
Granitoid rocks
Metasedimentary and volcanic rocks
Carbonate units designated by Sage (1954)
* abandoned in this study
** Wallace Brook Fm
Lakevale Fm.
Addington Fm.
NOTE
Stratigraphic column is not to scale. Thicknesses of units are indicated to the left of the column
after Boehner (1980)

Figure 3. Generalized stratigraphy, Antigonish Basin.

The interval from 584.4 m to 590.8 m in the drillhole is a highly brecciated mixture of halite, anhydrite and red to green siltstone. This breccia zone is interpreted as fault related and occurs at the approximate position of the Antigonish Thrust Fault (Fig. 4A). The salt breccia may be the remnants of the Hartshorn Formation salt associated with a low angle decollement. Alternatively (and with equal merit) the salt breccia could represent a high angle fault with injected salt of unknown age (Fig. 4B). This latter type of fault is common in the Antigonish Basin. The basal part of the Hood Island Formation and the entire Addington Formation and Hartshorn Formation were not intersected in the drillhole and were apparently removed by faulting.

Below the breccia zone, the drillhole intersected the Bridgeville Formation, a major section of anhydrite with 15 to 20 per cent limestone from 590.8 m to 819.8 m. Typical Macumber Formation laminite (limestone) was intersected from 819.8 m to 822.3 m, green, slightly calcareous, polymictic conglomerate from 822.3 to 829.3 m, and red conglomerate to the total depth at 846.7 m.

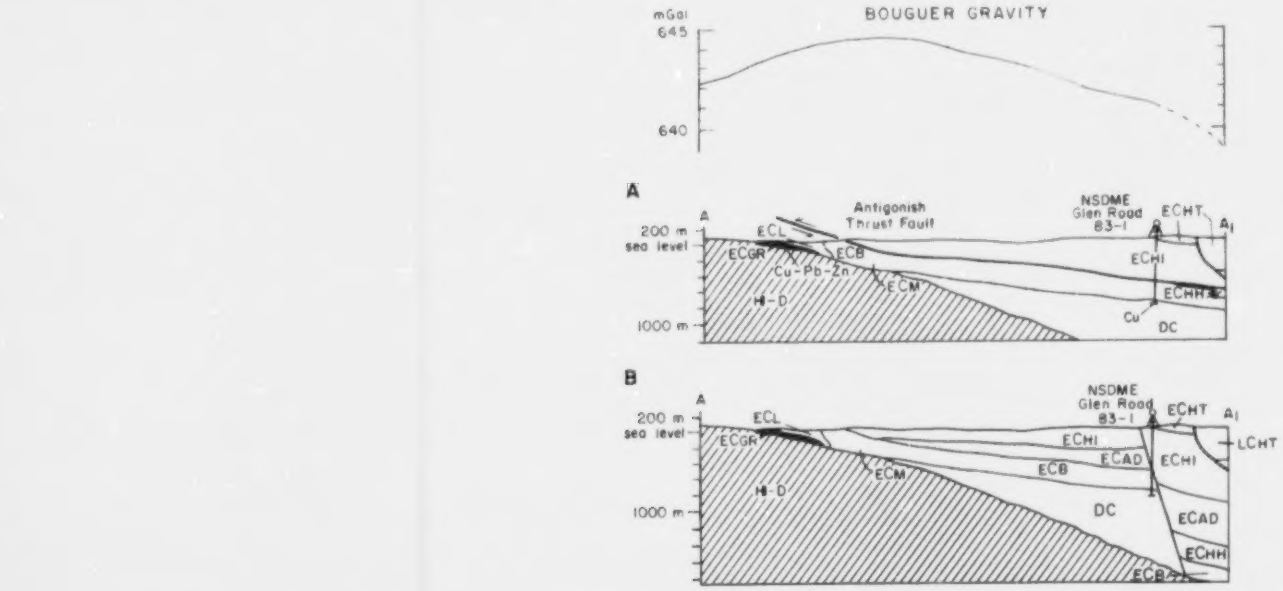
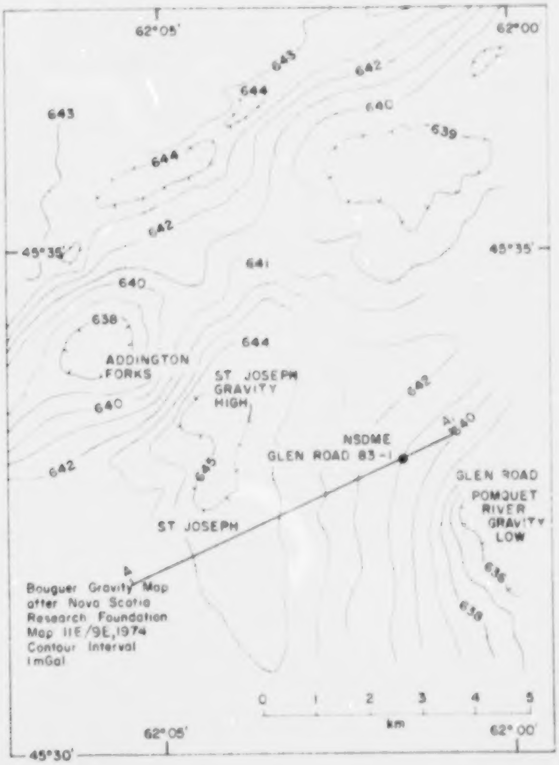

mGal
BOUGUER GRAVITY
645
640
A
A
Antigonish Thrust Fault
NSDME Glen Road 83-1
ECHT
A1
200 m
sea level
ECL
ECGR
ECB
Cu-Pb-Zn
ECM
ECHI
ECHH
H-D
Cu
DC
1000 m
B
A
NSDME Glen Road 83-1
ECHT
A1
200 m
sea level
ECL
ECGR
ECHI
ECAD
ECHI
LCHT
ECB
ECM
H-D
DC
1000 m
ECAD
ECHH
ECB

Figure 4. Alternative cross-sections, western border Antigonish Basin, based upon diamond-drill hole NSDME Glen Road 83-1 (see Fig. 1 for legend).

MINERAL OCCURRENCES

Mineral occurrences in NSDME Glen Road 83-1 are of two principal types: (1) structurally (fault) related i.e. the thin halite breccia unit and veinlets with calcite-anhydrite and minor fluorite, and (2) Windsor Group-Horton Group contact related Cu-Pb-Zn.

The salt breccia is not economically significant but indicates the Hartshorn Formation salt with possible potash probably occurs further to the east (Fig. 5, Pomquet River gravity low). The drill site is located near the transition from the St. Joseph Bouguer gravity high to the Pomquet River gravity low (Fig. 5). The Pomquet River gravity low may reflect the


62°05'
62°00'
643
644
642
640
639
643
644
642
45°35'
45°35'
641
640
638
644
ADDINGTON FORKS
ST JOSEPH GRAVITY HIGH
640
642
A'
640
NSDME GLEN ROAD 83-1
642
643
GLEN ROAD
POMQUET RIVER GRAVITY LOW
ST JOSEPH
A
636
638
0
1
2
3
4
5
km
62°05'
62°00'
45°30'

Bouguer Gravity Map after Nova Scotia Research Foundation Map 11E/9E,1974 Contour Interval 1mGal

Figure 5. Bouguer gravity anomaly map, western part of the Antigonish Basin.

limits of a major salt mass. The mineralized contact zone at the base of the Macumber Formation was channel sampled for chemical analyses (Table 1). The results confirm the presence of minor base metals down dip from known Cu-Pb-Zn occurrences near the western border of the Basin, 6 km to the west of the drillhole.

Table 1. Chemical analyses of the mineralized contact zone at the base of the Macumber Formation.

Sample Number	Depth (metres)	Lithology	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ag (ppm)
GR83-1	821.98 - 822.23	limestone	650	24	430	1.7
GR83-1	822.23 - 822.73	conglomerate	1410	8	710	0.1

REFERENCES

Boehner, R. C.
1980: Preliminary report on the Carboniferous geology of the Antigonish Structural Basin, Antigonish County, Nova Scotia; *in* Mineral Resources Division, Report of Activities, 1979; Nova Scotia Department of Mines and Energy, Report 80-1, p. 147-163.

Boehner, R. C. and Giles, P. S.
1982: Geological map of the Antigonish Basin, Nova Scotia; Nova Scotia Department of Mines and Energy, Map 82-2, scale: 1:50 000.

Giles, P. S. and Boehner, R. C.
1982: Subdivision and regional correlation of strata of the Upper Windsor Group, Cape Breton Island and central Nova Scotia; *in* Mineral Resources Division, Report of Activities, 1981; Nova Scotia Department of Mines and Energy, Report 82-1, p. 69-78.

Sage, N. M.
1954: The stratigraphy of the Windsor Group in the Antigonish quadrangles and the Mahone Bay-St. Margarets Bay area, Nova Scotia; Nova Scotia Department of Mines, Memoir 3, 168 p.

REGIONAL GEOCHEMICAL SURVEYS*

P. J. Rogers and M. A. MacDonald

During the 1983 field season, a regional geochemical sampling program was completed for northern Nova Scotia (Fig. 1). This was a joint project under the Canada-Nova Scotia Co-operative Mineral Program 1981-84.

REGIONAL PROGRAM

In northern Nova Scotia an area of about 10 000 km^2 was sampled: 4100 stream and 350 lake sediment and approximately 4500 water samples were collected. The stream sediments will be analyzed for Cu, Pb, Zn, Ag, Co, Ni, Fe, Mn, Mo, Hg, U and As; the lake sediments will be analyzed for these elements plus V, Cd, and loss-on-ignition (LOI). All water samples will be analyzed for U, F and pH.

The data will be released as Open File, single element maps (1:50 000 scale), commencing with NTS sheet 11K/01 early in 1984. Each map will contain details of sample types, location numbers, elemental values, plus basic statistics and histograms. Regional compilation maps at 1:250 000 scale will be published in due course. These compilation maps will contain sample data from previous years surveys reanalyzed and realigned to a common datum.

ORIENTATION SURVEYS (1982)

MEAT COVE Zn DEPOSIT

A magnesian skarn is found in the dolomitic limestones and schists of the George River Group at Meat Cove in northen Cape Breton (Neale, 1964). Based on chemical traverses across the orebody, Chatterjee (1979) reported a net introduction into the wall rocks of Zn, Cu, Pb, Fe and Hg, with enhancement of existing levels of Cd, As, Sn, Ge, Zr and Ni. During 1982 a total of 33 stream sediment samples were collected at 150 m intervals near the orebody and at 300 m intervals further downstream.

COXHEATH Cu DEPOSIT

On Coxheath Mountain in southeastern Cape Breton, chalcopyrite mineralization occurs within shear zones at the contact between mixed volcanics and a quartz diorite intrusive complex. Chatterjee (1980) reported B, Sc, Co, Ni, Cr, Cu, Mo and Zn within the orebody. Thirty-eight stream sediment samples were collected in the area at spacings similar to those used in the Meat Cove survey. An additional 600 m interval was used in the Coxheath survey at about 5 km downstream of the deposit.

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*Contribution to Canada-Nova Scotia Co-operative Mineral Program 1981-84. Project carried by Geological Survey of Canada and Nova Scotia Department of Mines and Energy.

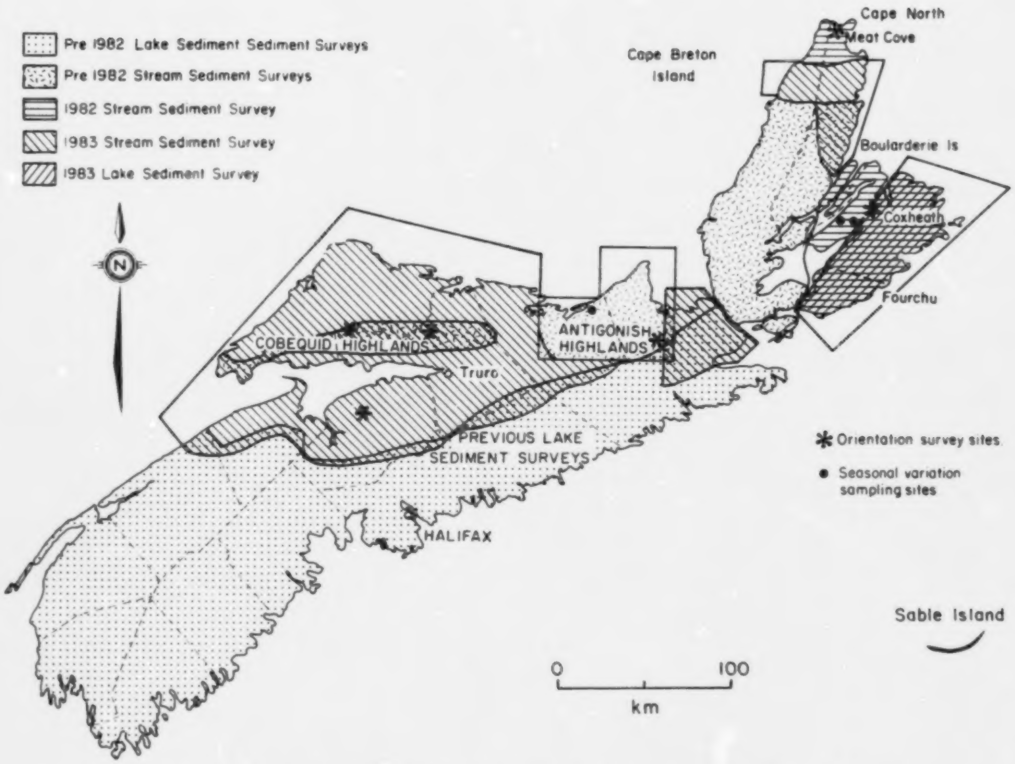
Pre 1982 Lake Sediment Sediment Surveys
Pre 1982 Stream Sediment Surveys
1982 Stream Sediment Survey
1983 Stream Sediment Survey
1983 Lake Sediment Survey
N
Cape Breton Island
Cape North
Meat Cove
Boularderie Is
Coxheath
Fourchu
ANTIGONISH HIGHLANDS
COBEQUID HIGHLANDS
Truro
PREVIOUS LAKE SEDIMENT SURVEYS
HALIFAX
Orientation survey sites
Seasonal variation sampling sites
Sable Island
0
100
km

Figure 1. Areal extent of regional geochemical surveys Canada-Nova Scotia Co-operative Mineral Program 1982 and 1983.

RESULTS

The samples sets from both surveys were analyzed by Atomic Absorption Spectroscopy (AAS) for Cu, Pb, Zn, Ni, Co, Ag, Mn, As, Mo, U and Hg and by Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES) for As, Mo, Zn, P, Pb, Cd, Co, Ni, Ba, Fe, Mn, Cr, Mg, V, Al, Be, Ca, Bu, Ag, Ti, Sr, Na and K.

Both analytical techniques yielded broadly comparable results. Each deposit has a characteristic trace element pattern dispersed into the stream sediments (Fig. 2). The Meat Cove and Coxheath deposits exhibit both positive and negative anomalies (decreasing and increasing values away from the ore body respectively). Selected examples of the anomaly types from both orebodies are illustrated in Figure 3.

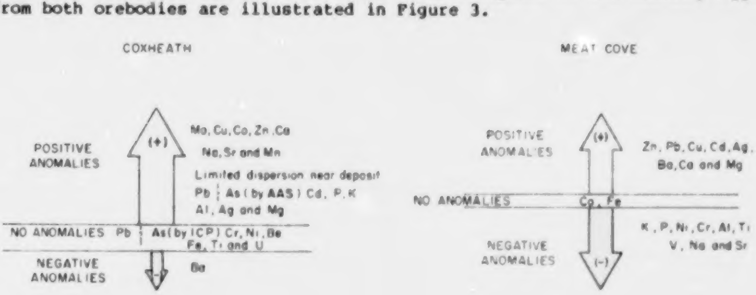
COXHEATH
POSITIVE ANOMALIES
(+)
Mo, Cu, Co, Zn, Ca
Na, Sr and Mn
Limited dispersion near deposit
Pb
As (by AAS) Cd, P, K
Al, Ag and Mg
NO ANOMALIES
Pb
As (by ICP) Cr, Ni, Be
Fe, Ti and U
NEGATIVE ANOMALIES
(-)
Ba
MEAT COVE
POSITIVE ANOMALIES
(+)
Zn, Pb, Cu, Cd, Ag,
Ba, Ca and Mg
NO ANOMALIES
Co, Fe
K, P, Ni, Cr, Al, Ti
V, Na and Sr
NEGATIVE ANOMALIES
(-)

Figure 2. Geochemical characteristics of the stream sediments.

At Meat Cove anomalous Zn values occur in stream sediments up to 4.5 km downstream of the deposit. Similarly, a 2 km dispersion occurs for Ag and Pb and a 2.5 km dispersion for Ba. ICP-AES analyses show Cd, Fe and Mo anomalies over the entire stream length (4.5 km). The Coxheath survey displays a more erratic and restricted pattern of anomalous samples. Only Cu (4 km) and Mo (3 km) were found to have any significant (i.e. regional) dispersion.

Using a detailed sampling density, the stream sediments from both deposits have a characteristic geochemical contrast. However, at the regional scale of sampling, a more restricted number of elements are useful in defining anomalies. Based on the results of the two orientation surveys to date, the regional field sampling method and sample spacing of approximately 2 km used in present surveys are sufficient to detect similar deposits. It is also interesting to note the generally flat geochemical response for the Coxheath survey compared to the Meat Cove survey. This probably reflects the greater hydraulic gradient at Meat Cove. If a low hydraulic gradient is a detrimental factor, the use of stream sediment sampling techniques in low, flat-lying areas like southeastern Cape Breton is perhaps questionable. It is hoped that the 1983 lake sediment survey conducted in this area will help to clarify this matter.

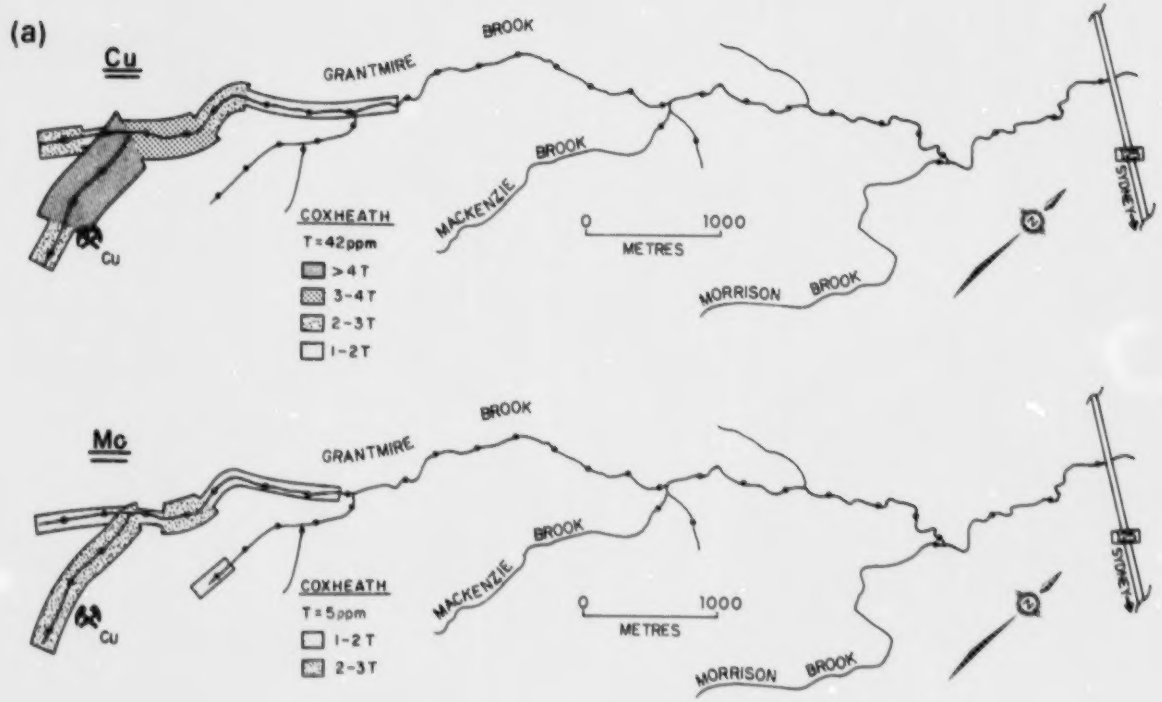
(a)
Cu
GRANTMIRE
BROOK
MACKENZIE
BROOK
MORRISON
BROOK
SYDNEY
0
1000
METRES
Cu
COXHEATH
T=42ppm
>4T
3-4T
2-3T
1-2T
Mo
GRANTMIRE
BROOK
MACKENZIE
BROOK
MORRISON
BROOK
SYDNEY
0
1000
METRES
Cu
COXHEATH
T=5ppm
1-2T
2-3T

Figure 3. Selected geochemical dispersion patterns for (a) Coxheath and (b) Meat Cove orientation surveys.

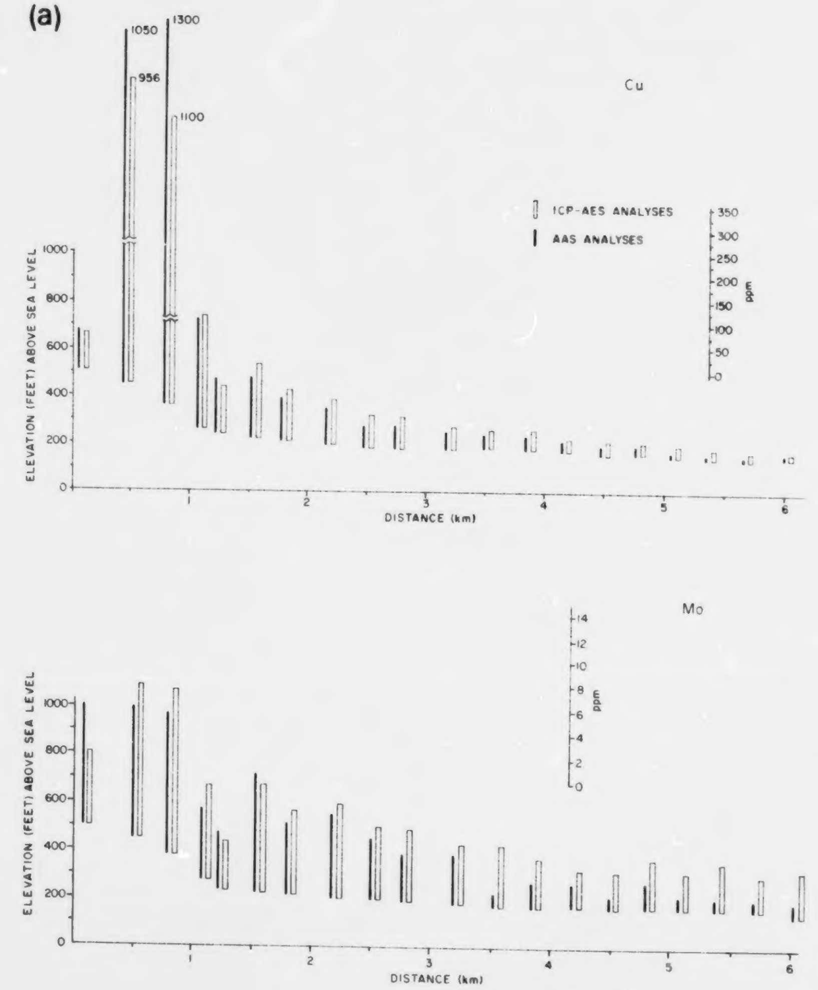

Figure 3. Continued.

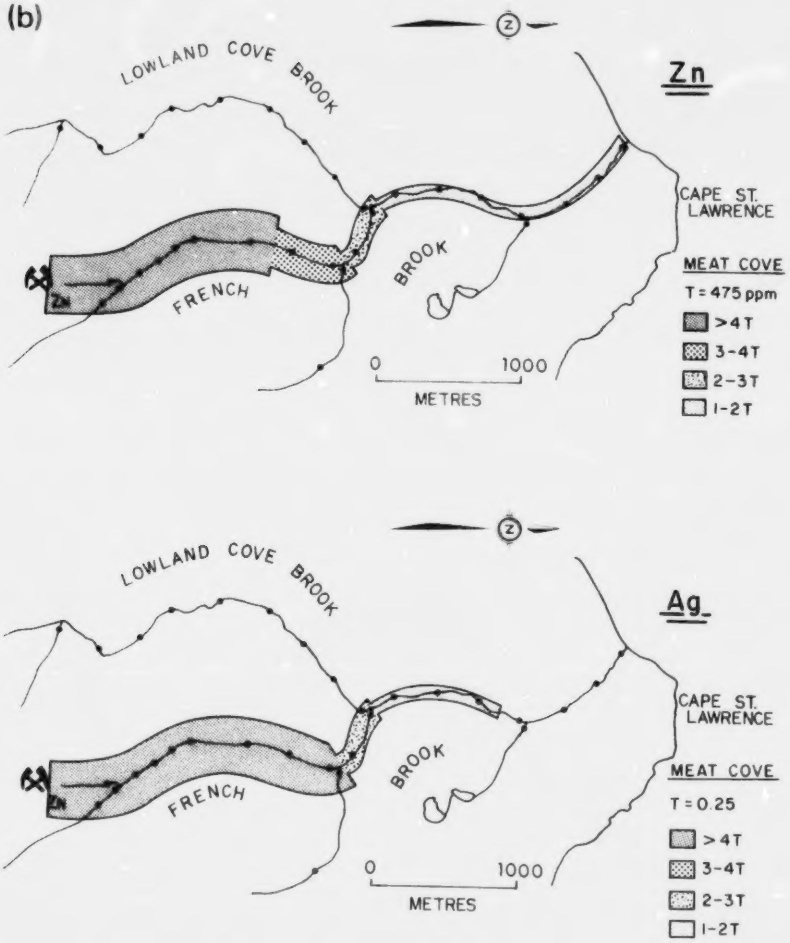
(b)
Z
LOWLAND COVE BROOK
Zn
CAPE ST. LAWRENCE
BROOK
FRENCH
Zn
MEAT COVE
T = 475 ppm
> 4T
3-4T
2-3T
1-2T
0
1000
METRES
Z
LOWLAND COVE BROOK
Ag
CAPE ST. LAWRENCE
BROOK
FRENCH
Zn
MEAT COVE
T = 0.25
> 4T
3-4T
2-3T
1-2T
0
1000
METRES

Figure 3. Continued.

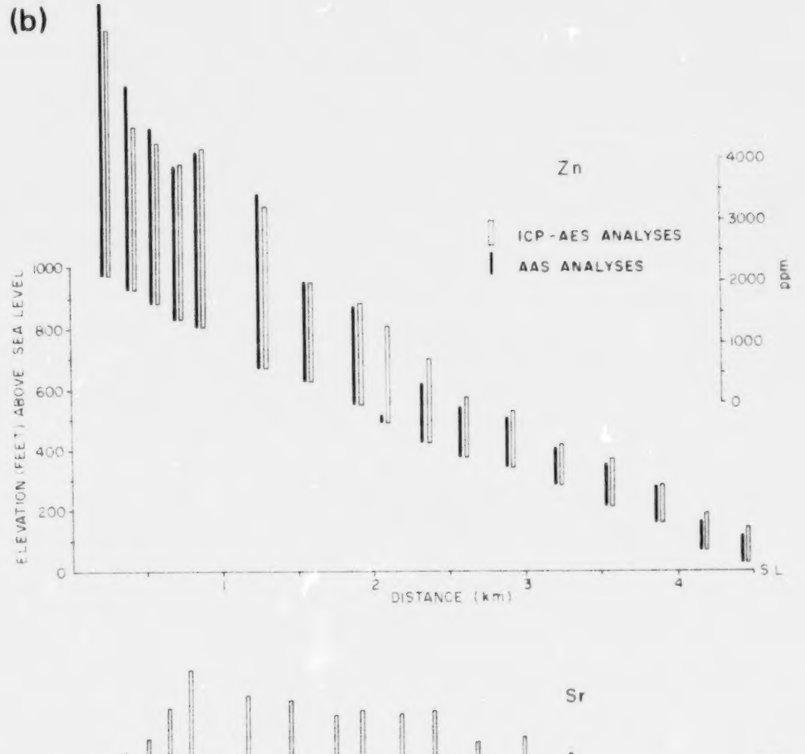

Figure 3. Continued.

Although still awaiting a detailed statistical analyses of the data, we have noted that the ICP-AES method gives conformable Zn values when compared to AAS. Higher readings for Cu, Ag, Ni, Mn, Mo and Fe are noted when analyzed by ICP-AES. Similar Pb values are also found using both methods, however ICP-AES displays less background-anomaly contrast.

SEASONAL VARIATION PROGRAM

The aim of the seasonal variation project is to evaluate within-site variations and monthly variations in elemental concentrations from stream sediments at selected sample sites. Each month, at each sample site, two samples are individually wet sieved in the field (to -1 mm). The -80 mesh fractions from these samples are analyzed for Cu, Pb, Zn, Co, Hg, Mn, Fe, Ni, Ag, Mo, Ag and U. In July 1982 the following two sample locations were chosen on Cape Breton Island (Fig. 1): (1) Beaver Cove Brook, which drains granitoid rocks; and (2) McLeod Brook, which drains mixed volcanics and sediments. These streams were chosen for their accessibility and their supply of "active" stream sediment, enabling repeated sampling at a specific sediment trap. Sampling at Beaver Cove Brook and McLeod Brook continued until April 1983. Sampling at a third location, James River, Antigonish County, began in November 1982 and will continue until further notice. This stream drains mixed volcanic and sedimentary rocks.

Preliminary results from McLeod Brook and Beaver Cove Brook for the period July 1982 to January 1983 are presented in Figure 4. The vertical bars represent within-site variation (i.e. two samples at each site). The lines which connect the median points of the bars indicate the seasonal variations. Both Ag and Mo values are below the detection limit. However, for the remaining elements substantial within-site variations (e.g. 10 to 15 ppm Cu for MB; 2.1 to 2.4 ppm U for BCB) and seasonal variations (e.g. 61 to 70 ppm Zn for MB; 18.5 to 22 ppm Pb for BCB) are noted.

The seasonal variation patterns from McLeod Brook and Beaver Cove Brook are presented in Figure 5; to facilitate comparison, July values have been made equal. The streams seem to behave differently on a seasonal basis. Cu and Fe display the most dissimilar patterns. From the initial results, there are substantial elemental variations in both seasonal variation and within-site samples. These effects may be due to a combination of mechanical dispersion, pH, water level, supply of organic material, eH, rainfall, temperature or physicochemical variations in the water/stream sediment environment.

PILOT STUDIES

During the 1983 field program, we investigated the use of stream water and heavy minerals as exploration mediums.

STREAM WATERS

A selected suite of elements from 50 sample sites in northern Nova Scotia were analyzed by AAS and ICP-AES to assess each method's detection limit and applicability for routine exploration. At each sample site a double sample was taken: one was acidified to 1 per cent with concentrated hydrochloric acid, the other was not acidifed.

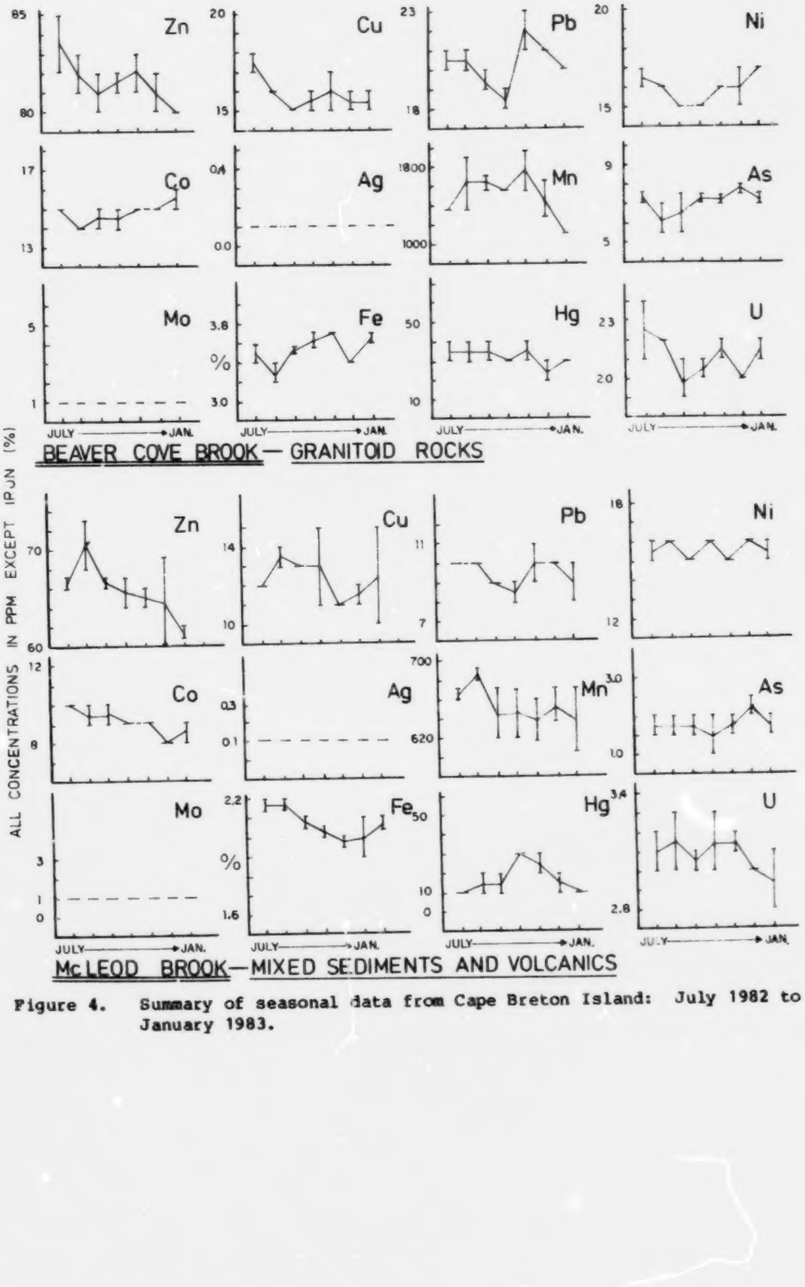

Figure 4. Summary of seasonal data from Cape Breton Island: July 1982 to January 1983.

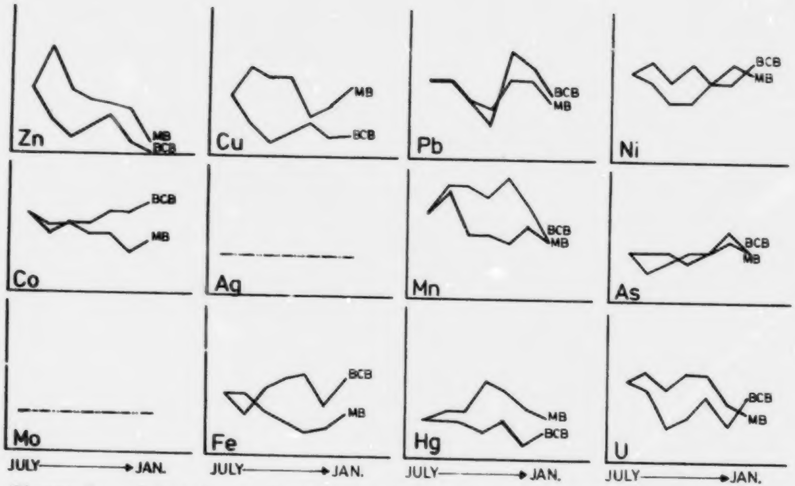

Figure 5. Comparison of seasonal variation on McLeod Brook and Beaver Cove Brook.

Each sample was analyzed for: Na, K, Ca, Mg, Al, B, Ba, Be, Fe, Mn, Sn, Sr, As, Cd, Co, Cr, Cu, Ni, Pb, Sb, Se, V, Zn, Li, Rb, R and U. The data await further statistical work.

HEAVY MINERALS

At selected sites (Fig. 1) two 500 g samples of -1 mm silt were collected. One of the sample pairs was panned to about a 50 g concentrate; the other was not panned. The efficiency of recovery of heavy minerals will be tested by passing both sets of samples through a magnetic separator. The heavy minerals from the unpanned silt will be obtained by heavy liquid separation. In addition, we hope to characterize the various deposit types by their heavy mineral content.

The following analyses are planned:

Highly magnetic fraction:	Fe, Ti, Cr
Slightly magnetic fraction:	Fe, Cu, Ti, Cr, U, Ce, La
Nonmagnetic fraction:	Sn, Mo, W, Be, As, Au, Zn, Cu, Ba, Zr, Sb, Pb
Light fraction from heavy liquid separation:	Mn, Cu, Be, Pb, Zn, Be

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AN INVESTIGATION OF THE GEOCHEMICAL REFLECTION OF Au MINERALIZATION IN THE TILLS AND LAKE SEDIMENTS OF THE EASTERN SHORE REGION OF NOVA SCOTIA*

P. J. Rogers, R. R. Stea and M. A. MacDonald

SYNOPSIS

The statistical evaluation by non-parametric ranking methods of regional till and lake sediment data is described. Significant differences are noted for As and Pb in lake sediments within a 5 km radius of known Au mineralization. A distinctive geochemical signature is noted for the tills and lakes within drumlin fields. The far travelled nature of the drumlins produces a distinctive association of Ni-Co-Fe-Mg-Mn-Ca-As when compared to tills and lakes developed on the local host lithologies. A number of unique associations are found to characterize both the sampling mediums. The tills have a robust Cu-Pb correlation while the lakes have a marked correlation between Fe-Mn-Co-Ni.

The study demonstrates the applicability of non-parametric statistical methods when comparing geochemical associations within differing regional survey mediums. It is noted that As and Pb in lake sediments and Cu and Pb in tills could be used as pathfinders for Au mineralization in Nova Scotia.

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* Prospecting in areas of glaciated terrain, Sixth International Symposium; Institution of Mining and Metallurgy, Glasgow, Scotland, May 1984.

PATTERNS OF GLACIER MOVEMENT IN CUMBERLAND, COLCHESTER, HANTS AND PICTOU COUNTIES, NORTHERN NOVA SCOTIA*

R. R. Stea and P. W. Finck

ABSTRACT

Mapping of glacial features and till sheets in Cumberland, Colchester, Hants and Pictou counties has been completed. Preliminary results indicate four major ice-flow phases. The first phase was an eastward and southeastward movement which formed a compact, reddish-brown lodgment till. After a brief recession, indicated by alteration at the top of the lodgment till, a glacier moved south-southwestward across the map area. Boulder pavements separating two till sheets along the Northumberland Strait also record this change in ice-flow direction. A major flow reversal then occurred with ice flowing northward and northeastward from a centre in the Southern Uplands. Erratics derived from the South Mountain batholith were transported north during this flow. Striations trending 260-290° cut across striations made by the northeastward flow and represent a final pulse of ice flow westward into the Minas Basin. The early eastward flow is speculated to be Early Wisconsinan as striations relating to it are inscribed on a wave-planed rock bench assigned a Sangamon age. The last two flow phases are assigned late Wisconsinan ages on the basis of radiocarbon dates on surficial organic deposits.

INTRODUCTION

Mapping of the surficial deposits and glacial features in northern Nova Scotia is part of a project that includes trace element analyses of till.

The area covered by this report lies between latitudes 45°15'N and 45°55'N and longitudes 62°45'W and 64°20'W.

PHYSIOGRAPHY AND GENERAL GEOLOGY

The study area consists of three physiographic regions: Cumberland-Pictou Lowlands, Hants-Colchester Lowlands and Cobequid Highlands (Goldthwait, 1924). The lowland areas are underlain predominantly by Early Carboniferous to Triassic sedimentary rocks. The highland region is formed by metasedimentary, volcanic and igneous rocks of Hadrynian, Silurian, Devono-Carboniferous and Early Carboniferous ages that are segregated into numerous fault blocks and bounded on the south by the Minas Geofracture (Donohoe and Wallace, 1978, 1982; Keppie, 1982).

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* Also in Current Research, Part A, Geological Survey of Canada, Paper 84-1A, p. 477-484, 1984.
Contribution to Canada-Nova Scotia Co-operative Mineral Program 1981-84. Project carried by Geological Survey of Canada and Nova Scotia Department of Mines and Energy.

SUMMARY OF PREVIOUS WORK

Chalmers (1895) developed a relative chronology of ice-flow events based on striation mapping. He recognized an early eastward movement of ice in the lowlands which he termed the Northumberland Glacier. He postulated that the centre of outflow for this glacier was the highlands of central New Brunswick. Striations indicating a southward and southwestward ice flow were attributed to the 'Chignecto Glacier' centred on the isthmus of Chignecto. A plot of all his striation measurements in the map area indicates a major northward ice flow (Fig. 1). He attributed these striations to unnamed glaciers that had accumulated on the Cobequid Highlands and local summits in the lowlands. His interpretations are largely borne out by this study.

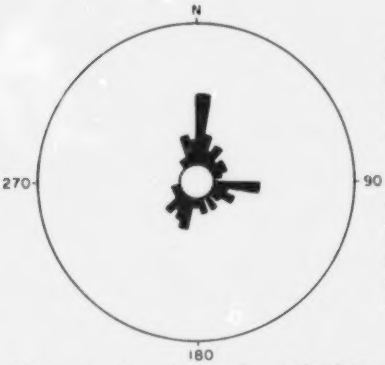

Figure 1. A plot of striations measured in the map area by Chalmers (1895).

Prest et al. (1972) advocated a similar sequence of events, but stressed the concept of a later, northward-flowing ice cap in the eastern Cobequid Highlands based on abundant Cobequid-derived erratics in the lowlands.

Grant (1977) recognized that the last ice flow apparent in the Chignecto Bay area was opposite to the northward flow predominant in areas to the east. He suggested that these movements may have been synchronous, but not in contact.

Recent work by exploration companies in the search for uranium has provided new data on the glaciation of the Cobequid Highlands. Downey (1979) recognized two major movements in the highlands east of the Wentworth Valley. He stated that the first ice movement was toward the south-southeast and emplaced a reddish-brown till, followed by a northwestward ice flow which formed a greyish till.

Stea (1982) designated four major till-forming events in the Hants-Colchester Lowlands south of the map area. They are summarized as follows:

1. East Milford Till - formed by a regional east-southeast ice flow.
2. Hants Till - formed by southward flowing ice, later reworked by northeastward flowing ice.
3. Bennett Bay Till - formed by northward flowing ice crossing the North Mountain cuesta.
4. Rawdon Till - formed by westward flowing ice.

EROSIONAL INDICATORS OF GLACIER MOVEMENT

CUMBERLAND-PICTOU LOWLANDS

Stossed and striated bedrock surfaces in this region commonly record a flow towards 090-110°. Ridges with a concordant trend are also evident in the lowlands (Fig. 2). Large boulders embedded in till along the coast exhibit striated surfaces with bullet-nosed up-glacier terminations and abruptly truncated down-glacier terminations (cf. Boulton, 1978) that indicate an eastward flow (Fig. 3).

At many sites in the lowlands striations trending 204-233° clearly cut across the eastward-trending sets (Fig. 4). These striations are found on north-facing stoss surfaces along the coast (Fig. 2).

Chalmers (1895, p. 74) described striations on south-facing stoss surfaces trending 000-020°. The authors also found weakly striated, south-facing stoss surfaces, bevelling till-covered surfaces striking 230°.

COBEQUID HIGHLANDS

Many striations trending 170-195° were measured on the highlands. The sense of this ice flow was verified at several localities by distinctly north-facing stoss surfaces and from pressure shadows or mini crag-and-tail features developed on quartz veins (Fig. 2).

South-facing stoss surfaces produced by northward flow were also seen at many sites where the southward flow was recorded. Striations developed on these surfaces ranged from 350° to 035°. The sense of this flow was verified at several localities by miniature crag-and-tail on quartz veins in volcanic and metasedimentary rocks and on pebbles in conglomerates. At some sites the southward-trending striations are cut by the northward-trending sets, and at others the two bevelled faces meet along a line (Fig. 5).

At several sites in valleys on the uplands striations trending east and southeast that are preserved in deep grooves are crossed by the northward- and southward-trending sets. The occurrences of eastward- and southeastward-trending striations on the highlands are rare.

HANTS-COLCHESTER LOWLANDS

Rock exposures in this region reveal evidence of two major ice flows, toward the northeast and west-southwest. The sequence of these flows is revealed at stop 299 (Fig. 2). Striations trending 247° crosscut wide grooves on a flat bedrock surface inscribed with black-stained striations trending 020°. At Tennycape Quarry (Fig. 2) striations relating to earlier southward and southeastward ice flows occur on bedrock under 6 m of till, and striations trending 028° and 281° were found near the surface (Fig. 6).

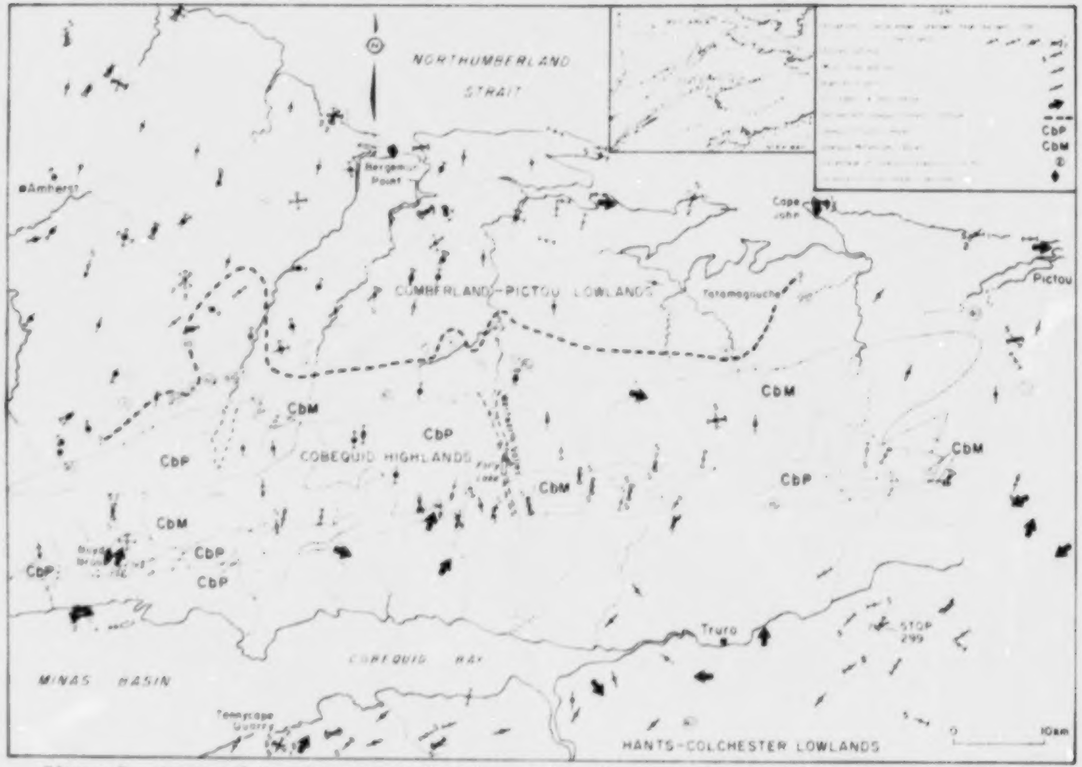
NORTHUMBERLAND STRAIT
Amherst
Bergemor Point
Cape John
Pictou
Tatamagouche
CUMBERLAND-PICTOU LOWLANDS
COBEQUID HIGHLANDS
CbM
CbP
Truro
STOP 299
COBEQUID BAY
MINAS BASIN
Tennycape Quarry
HANTS-COLCHESTER LOWLANDS
0
10km

Figure 2. A map of the features indicative of ice flow in parts of Hants, Pictou, Cumberland and Colchester counties.

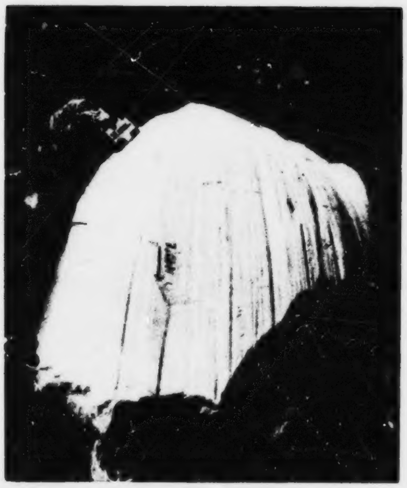

Figure 3. A striated boulder with a bullet shape that indicates transport by sliding in the basal zone of traction and an eastward sense of flow (093°). Overlain by 6 m of till.

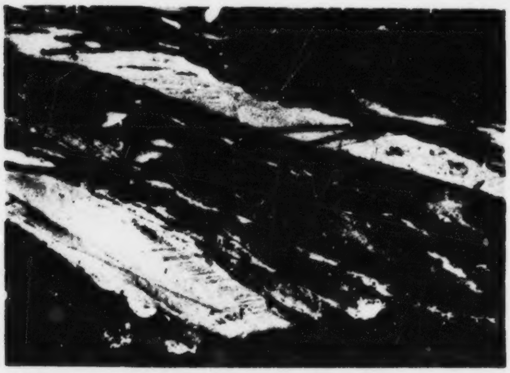

Figure 4. Striations and grooves trending 204° crosscut a groove and striations trending 089°, near Pictou along the Northumberland Strait.

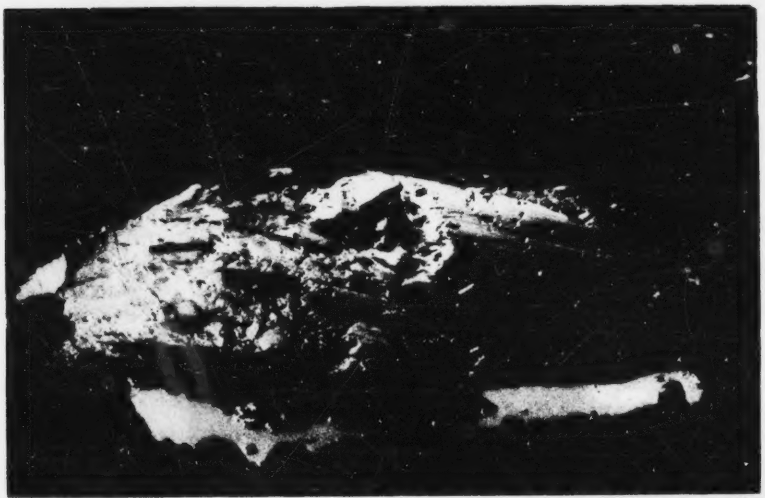

Figure 5. Stoss-and-lee form and striations on Cobequid Highland granite indicate a flow towards 181°. On the south-facing part of the outcrop striations trend 011° and meet the 181° striations at a bevel contact (dashed line).

Figure 6. At Tennycape Quarry an upper surface (marked by compass) bearing striations trending 281° truncates striations trending 028° (marked by pencil). The sense of flow of the 028° set was verified by miniature crag-and-tail features at a nearby locality.

TILL PROVENANCE AND ERRATIC DISPERSAL

CUMBERLAND-PICTOU LOWLANDS

The surface till sheet throughout most of this area is a reddish-brown, jointed, sandy-silt till composed primarily of Carboniferous (Cumberland Group) sandstone clasts. It has been observed to overlie bedrock with striations trending 210° (Fig. 7). Igneous and metamorphic erratics are commonly found in the top 2 m of this till and on the surface. Many of these erratics are hornblende-bearing diorites of similar description to diorites making up the large plutons of the Cobequid Highlands (H.V. Donohoe, personal communication, 1983). There is a general increase in the abundances of these crystalline erratics from north to south and from west to east (Fig. 2). There are also areas of high erratic concentrations which are located opposite major U-shaped valley systems such as the Wentworth Valley (Fig. 2).

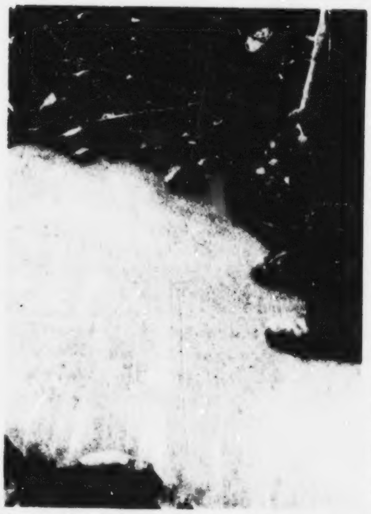
Figure 7. Southwest of Amherst a reddish-brown till with Carboniferous clasts overlies a stained and striated bedrock surface. The striations trend 210°.

Several exposures along the coast reveal two and locally three till units. At Bergeman Point a very compact, greyish-red basal till is overlain by two less compact tills. The contact is marked by a pavement of boulders which are inscribed with striations trending 210°. Nearby the basal unit overlies bedrock with striations trending 093°.

At Cape John a 9 m section reveals three till units (Fig. 8). Unit I, a reddish-brown silt till, rests on bedrock with striations trending 105°. Striations on the boulder pavement between units I and II give evidence of only slight variations in the eastward flow. Boulders with striations trending 060° or 240° suggest changing flow directions, perhaps to the southwest. Unit II is a greyish-brown till with a silty matrix. Unit III is a greyish-red till with few clasts and a sandy-silt matrix. Embedded in unit III in the top 2 m are volcanic and foliated granitic boulders of probable Cobequid Highland provenance. Striations on a boulder in this unit suggest a N15°E movement. Till fabric measured below these boulders, however, reveals only modes of orientation compatible with eastward and perhaps southwestward ice flows. The pebble layer and manganese oxide coatings in the top parts of units II and III are suggestive of soil formation indicating a period of climatic amelioration. Alternatively, the manganese oxide could also represent groundwater modification of the pebble zones with no climatic significance. At Joggins, 60 km to the west, a

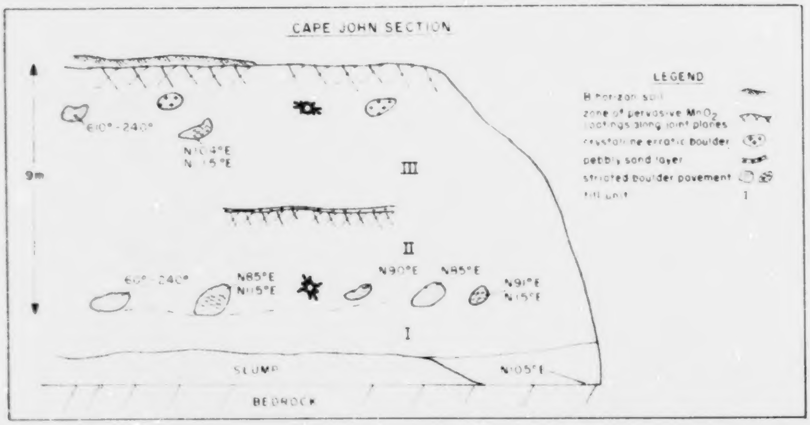
CAPE JOHN SECTION
LEGEND
B horizon soil
zone of pervasive MnO2 coatings along joint planes
crystalline erratic boulder
pebbly sand layer
striated boulder pavement
till unit
I
9m
60°-240°
N104°E
N115°E
III
II
I
60°-240°
N85°E
N115°E
N90°E
N85°E
N91°E
N115°E
SLUMP
N105°E
BEDROCK

Figure 8. Diagrammatic cross-section of three tills, Cape John, near Pictou, Nova Scotia.

similar alteration zone on a till produced by eastward-flowing ice lends some credence to the first hypothesis (Stea, 1983).

COBEQUID HIGHLANDS

Much of the Cobequid Highland area is veneered by a reddish-brown till with varying percentages of sandstone clasts derived from the Cumberland-Pictou Lowland region. A greyish-brown till of Cobequid Highlands provenance was found to overlie the reddish-brown till at several localities and contains inclusions of the older till. The grey till was observed to overlap onto the lowland terrain to the north. At Boyd Brook this till sheet produced a fabric concordant with northwestward-trending striatons and is presumed to have been formed during that flow. We concur with the conclusions of Downey (1979) that a till sheet was produced by a northward ice flow off the highlands.

Very compact, reddish-brown lodgment till with fabric striking 090°-115° was discovered in valleys in the Cobequids (Fig. 2). In most cases it is overlain by an oxidized greyish till.

HANTS-COLCHESTER LOWLANDS

The surface till sheet over much of the lowlands south of the Cobequid Highlands is a reddish-brown noncalcareous, sandy-silt till made up primarily of local (Horton Group) clasts. It has been informally termed the Hants Till (Stea, 1982). This till sheet contains 1%-10% Cobequid erratics, but in its upper 2 m can be found erratics derived from the South Mountian batholith located southwest of the map area (MacNeill *in* Prest et al., 1972; Stea, 1982). Elsewhere the Hants Till is locally overlain by a greyish-brown till with few crystalline erratics and a strong fabric striking 260-290°. This till has informally been termed the Rawdon Till (Stea, 1982).

Under the Hants Till is a more compact greyish-red till which overlies striations trending east and southeast and contains a higher percentage of Cobequid erratics (Cornish, 1980; Stea, 1982). This lower till has been termed the East Milford Till (Stea and Hemsworth, 1979).

DISCUSSION AND CONCLUSIONS

Figure 9 shows a plot of all striations for which the sense of ice flow is known. Four major groupings of striation directions are apparent. The sequence of these movements can be deduced from the 'type localities' of crossing striations and superposed tills associated with these ice flows.

The oldest flow pattern, set 1 of Figure 9, trends 090°-130° throughout the map area. North of the Cobequid Highlands the trend appears to have been due east. In the Cobequid Highlands a few striations and compact lodgment tills with an east-southeast striking fabric attest to the flow crossing the Highlands. Striations under thick drift sections in the Hants-Colchester Lowlands trend southeastward. Till units I and II at Cape John described in this report, unit I at Joggins (Stea, 1983), and the East Milford Till (Stea and Hemsworth, 1979) are all considered to have been deposited by this early ice flow.

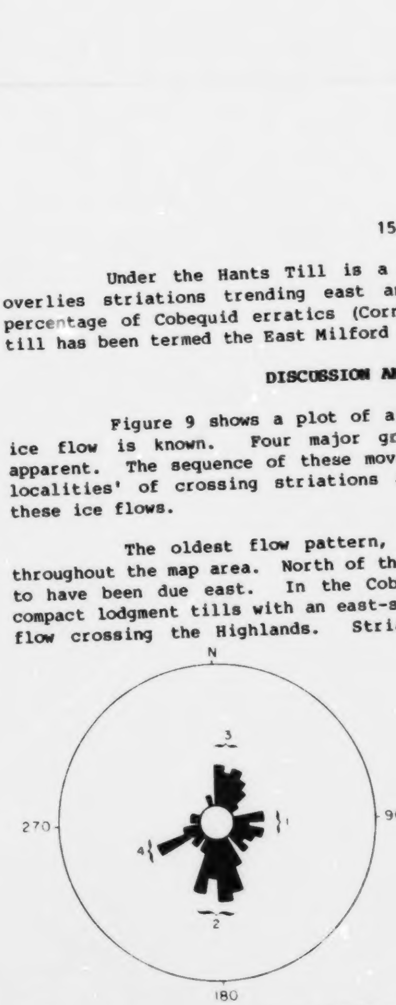

Figure 9. Plot of all striations measured by the author in the map area, for which the sense of ice flow is known. Relative ages of the four sets are noted.

Striations trending 160°-210°, represented by set 2 of Figure 9, cut across the early eastward-trending set at many localities (Fig. 2). These striations are most common in the Cumberland-Pictou Lowlands where they trend south and southwest and on the Cobequid Highlands where they trend generally southward. It is not known whether these striations represent a continuous ice flow conforming to topography, or if they represent a sequence of ice flows first toward the south-southeast and then toward the southwest. Unit II at Joggins (Stea, 1983) and the Hants Till (Stea, 1982) are believed to have been initially formed during this flow event.

A strong north and northeastward ice flow occurred after the period of southward ice flow in the area. The compelling evidence for this hypothesis is:

1. A till sheet and ablation boulders of Cobequid Highland provenance overly a till sheet of Carboniferous provenance in the Cumberland-Pictou Lowlands and Cobequid Highlands.

2. Striations trending north and northeast clearly cut striations trending south at many localities in the Cobequids.

The pattern of northeastward flow in the Hants-Colchester Lowlands can be traced across the southern slope of the Cobequid Highlands (Fig. 2). Since there is no evidence of its limit on the southern flank of the Cobequids it is suggested that instead of a Cobequid-centred source of northward ice flow (Prest et al., 1972) the flow probably originated in the region south-southwest of the map area, i.e. on the Southern Uplands. Earlier workers considered this flow to have emplaced granite boulders on the North Mountain cuesta (Dawson, 1868; Faribault, 1920; Hickox, 1962). However, no evidence for this flow was found in the highlands west of Parrsboro (Stea, 1983). The Southern Uplands ice may have been partly obstructed by the North Mountain and calving may have occurred in the deeper parts of the Minas Channel. Railton (1973) termed this ice mass the South Mountain Ice Cap.

The final pulse of ice flow appears to have been westward into Cobequid Bay and the Minas Basin. Striations relating to this flow are found throughout the Hants-Colchester Lowlands and cut the northeastward-trending set. The source of this ice may have been in the Antigonish Highlands, east of the map area. A late southwestward movement in the Chignecto Bay area (Stea, 1983) may be synchronous with the westward flow into the Minas Basin. The westward flow did not appear to affect the Cobequid Highlands, which at that time may have harboured a residual, stagnant carapace of ice.

The oldest striations, trending eastward and southeastward (set 1 of Fig. 9), were assigned a Wisconsinan age by Rampton and Paradis (1981) in New Brunswick. These striations were inscribed on a wave-cut rock bench which is elsewhere assigned a Sangamon age (Grant, 1980). The East Milford Till, formed by the oldest east-southeastward ice flow, overlies peat beds with wood that gave a nonfinite radiocarbon age: >52 000 BP (GSC-2684). The age of the East Milford Till was speculated to be Early Wisconsinan (Stea and Hemsworth, 1979; Stea, 1982). The age of the subsequent southward and southwestward ice flow is therefore uncertain. There is some indication of soil development on the East Milford Till (Cornish, 1980; Stea, 1982) which suggests that the southward ice flow (set 2 of Fig. 9) may have postdated an Early-Middle Wisconsinan recessional interval. The youngest two events (sets 3 and 4 of Fig. 9), however, are probably Late Wisconsinan in age. The South Mountain Ice Cap, probable source of the northward and northeastward flowing ice, persisted into the Holocene (Railton, 1973). Hadden (1975) also invoked a persistent ice cover to explain a relatively young bog-bottom date (9187 ± 255 BP, I-7080) in the Hants-Colchester Lowlands. She also noted that the spruce pollen maximum zone occurred 1000 years earlier in the Folly Lake area of the Cobequid Highlands (Hadden, 1975, p. 44).

On the basis of the present study the authors would modify Grant's (1977) model of Late Wisconsinan ice distribution to accommmodate a more extensive ice flow emanating from the South Mountain Ice Cap crossing the eastern Cobequid Highlands.

Figure 10 summarizes the inferred sequence of ice flows in the region.

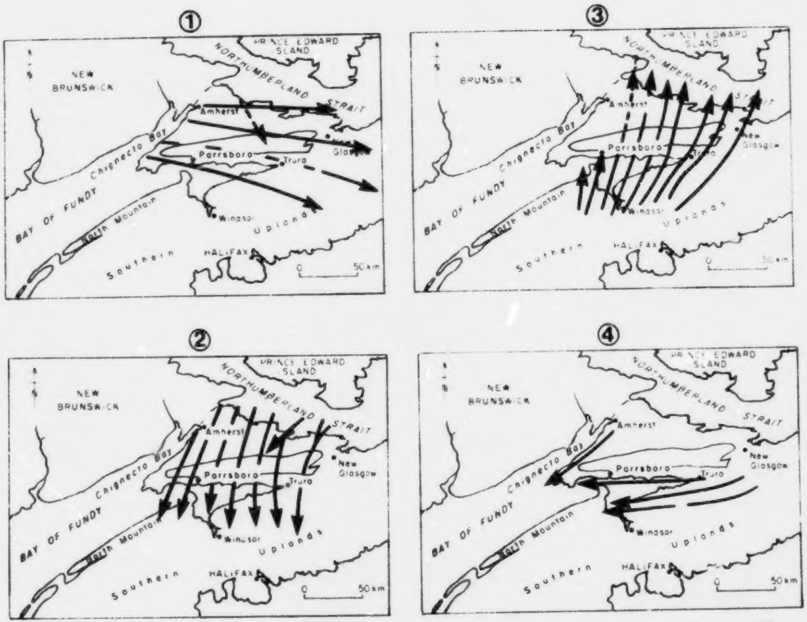
①
③
②
④
PRINCE EDWARD ISLAND
NEW BRUNSWICK
NORTHUMBERLAND STRAIT
Amherst
Chignecto Bay
Parrsboro
Truro
New Glasgow
BAY OF FUNDY
North Mountain
Windsor
Southern Uplands
HALIFAX
0 50 km

Figure 10. The inferred sequence of ice flows in the map area. Flow pattern 1 is speculated to be Early Wisconsinan in age; flow patterns 3 and 4 Late Wisconsinan.

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TILL STRATIGRAPHY AND GOLD DISPERSION, FOREST HILL GOLD DISTRICT, NOVA SCOTIA*

I. J. MacEachern, R. R. Stea and P. J. Rogers

ABSTRACT

In a program to aid gold exploration in Nova Scotia, the till stratigraphy and gold distribution (in till) at the former Forest Hill gold mine was extensively studied. At that location trenches cut to bedrock provide a unique opportunity to study the three-dimensional dispersal of gold from a known bedrock source by glacial and postglacial processes.

Three major surficial units characterise the till stratigraphy of the study area. The oldest unit is a washed and poorly cemented gravel restricted to topographically low areas. This is overlain by two tills characterized by a sandy matrix and locally derived granitic and metasedimentary clasts. These tills are separated by a reddish-brown zone interpreted to be a paleosol. The lower of the two younger tills is an olive-brown, moderately compact unit that rests upon bedrock inscribed with southeastward-trending striations. The upper till is yellowish-brown and less compact, and locally has a strong fabric indicating formation by a southwestward ice movement.

Gold dispersal trains from known auriferous veins have been defined in till at the Forest Hill area. These dispersal trains reflect the southeastward ice flow indicated by the till fabric studies and the predominant bedrock striations, and are most strongly associated with the older of the two younger till units in the area. Several other areas of gold-rich drift may be indicative of post-glacial processes or dispersal from undiscovered auriferous veins. Cursory microscopic examination of gold and heavy minerals from panned concentrates of the tills provides little evidence of abrasion during glacial transport.

ACKNOWLEDGMENTS

We are grateful to R. G. Turner for his able assistance in the field and to W. H. Poole of the Geological Survey of Canada for his support of this project. Special acknowledgment is given to Seabright Resources Inc. for their co-operation in allowing the study and providing maps and bedrock geochemical data.

INTRODUCTION

All of Nova Scotia's gold fields are overlain by till of differing thicknesses. Most of the known gold mineralization was discovered before the turn of the century by prospecters using unsophisticated drift prospecting techniques. In light of these facts and the gold prices in recent years, a renewed interest has been stimulated in the almost-forgotten gold fields that occur in rocks of the Cambro-Ordovician Meguma Group of the Province. This interest has generated an increased demand for information concerning the nature and distribution of gold in tills, particularly for exploration purposes.

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*Contribution to Canada-Nova Scotia Co-operative Mineral Program 1981-84. Project carried by Geological Survey of Canada and Nova Scotia Department of Mines and Energy.

The present study, as part of the Canada-Nova Scotia Co-operative Mineral Program 1981-84, was initiated in response to this demand. It is an integrated survey, involving the correlation of bedrock, till and soil geochemistry with the till stratigraphy of the area. The purpose of this study is to develop and refine geochemical exploration techniques for locating new gold deposits and re-evaluating old gold deposits in rocks of the Meguma Group.

During the summer and fall of 1982, an extensive trenching program conducted at the Forest Hill Gold District by Seabright Resources Inc. exposed approximately 3.5 km of drift cut to bedrock. Exposure is along 9 trenches oriented perpendicular to the strike of both the veins and host strata of the deposit (Fig. 1). This afforded the authors a unique opportunity to study the till stratigraphy and three-dimensional dispersal of gold and related elements from a known bedrock source by glacial and postglacial processes.

The following will deal primarily with the till stratigraphy and preliminary results on gold dispersion at Forest Hill as established through the systematic panning of the till units. The geochemical results of the survey were not available at the time of submission of this manuscript.

LOCATION AND PHYSIOGRAPHY

The Forest Hill Gold District is located in the central part of Guysborough County at latitude 45°20' N and longitude 61°45'W. It is 3 km south of the Salmon River road which runs between Country Harbour Crossroads and the Town of Guysborough.

The study area is a bedrock controlled topographic high, bounded to the north by drumlinized terrain and to the south by hummocky terrain. The orientation of several lakes north of the study area generally parallel the long axes of the drumlins (155°) and probably occupy glacially scoured basins.

Outcrop is scarce except where exposed in trenches and road cuts, and the thickness of the till veneer is strongly controlled by bedrock topography.

PREVIOUS WORK

Previous detailed work concerning the nature and distribution of gold in tills has not been extensive. Much of the pioneering work in this field, particularly in Nova Scotia, can be credited to W. H. Prest. In a program conducted at the Blockhouse Gold District in 1896, Prest traced and located an auriferous quartz vein that had eluded prospectors for over a

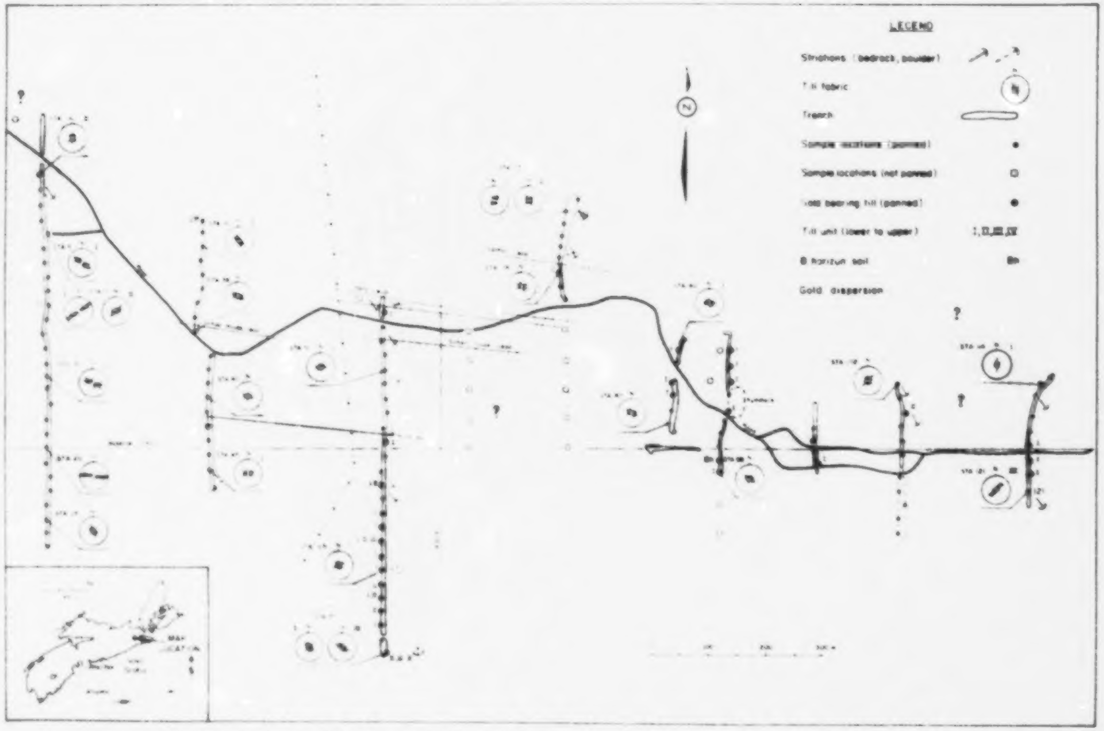

LEGEND
Striations (bedrock, boulder)
Till fabric
Trench
Sample locations (panned)
Sample locations (not panned)
Gold bearing till (panned)
Till unit (lower to upper)
I, II, III, IV
B horizon soil
Bh
Gold dispersion
N
?

Figure 1. Map of the Forest Hill area. Shown are the trenches, sample sites, ice movement indicators, and gold dispersal trains.

decade. He systematically sank reinforced shafts in the till and carefully mapped the gold dispersal as indicated through panning the vertical profiles. Prest (1911) emphasized the importance of a thorough understanding of both the regional and local Pleistocene geology in an effective drift prospecting program. This involved deciphering the till stratigraphy and the effects of post glacial processes.

The most recent and relevant work on gold in till has been done by DiLabio (1982a, b) and MacEachern (1983).

In 1981, DiLabio conducted two orientation surveys at the Waverley and Oldham Gold Districts of Nova Scotia. The objectives of the studies were (1) to test the relationship between grain size and gold abundance in till, and (2) to study dispersal trains around known gold occurrences. DiLabio (1982a and b) concluded that the fine sand, silt, and clay fraction (250 µm) of the till gave the best analytical results close to the source. The silt/clay fraction (<63 µm) was preferred when sampling at distances greater than 250 m from the bedrock source. He attributed this to the grinding down of the host rocks by glacial comminution.

MacEachern (1983) conducted a geochemical survey along trenches cut in till and soils at the Fifteen Mile Stream Gold District of Nova Scotia to study the distribution, character and composition of gold in till. Results of this study showed that (1) the distribution of gold in the till is affected by both chemical and mechanical processes, (2) the average composition of gold in the till (69% Cu, 10% Au, 9% Zn, 1% Ag), as determined using electron microprobe techniques, differs significantly from the average composition of primary gold from the deposit (91% Au, 9% Ag). This compositional difference is considered by MacEachern (1983) to be strong evidence supporting a hydromorphic redistribution of gold in till at the Fifteen Mile Stream area.

In agreement with DiLabio (1982a), MacEachern (1983) found the most auriferous grain size range for analyses to include the fine sand, silt, and clay fractions of the till. MacEachern (1983) also found high gold values in the coarse sand fraction, suggesting that the grain size distribution of gold in the till may be due largely to the inherent nature of the gold in the deposits, and not to the comminution process. MacEachern (1983) also noted that the lack of evidence for abrasion of the gold, studied under the scanning electron microscope, suggests minimal grain size reduction.

PROCEDURES

The till exposures at Forest Hill were systematically sampled at 25 m intervals along the trenches (Fig. 1). At each sample site the till stratigraphy was described and the section was systematically profile sampled at metre intervals. In addition to the sampling, each till unit was panned to obtain a heavy mineral concentrate for analyses. The coarse pebble fraction was removed using a gold pan sifter, and at least 100 pebbles were counted at every station and classified into lithological groups in the field. At every fifth site, pebble fabrics were measured. Till fabrics, pebble counts, and measurements of bedrock and boulder pavement striations were used to reconstruct former glacier movements in the Forest Hill area.

Panned heavy mineral concentrates were analyzed using a binocular microscope. Photographs of the heavy mineral suites including gold, ilmenite and garnet were taken using a scanning electron microscope (Fig. 2).

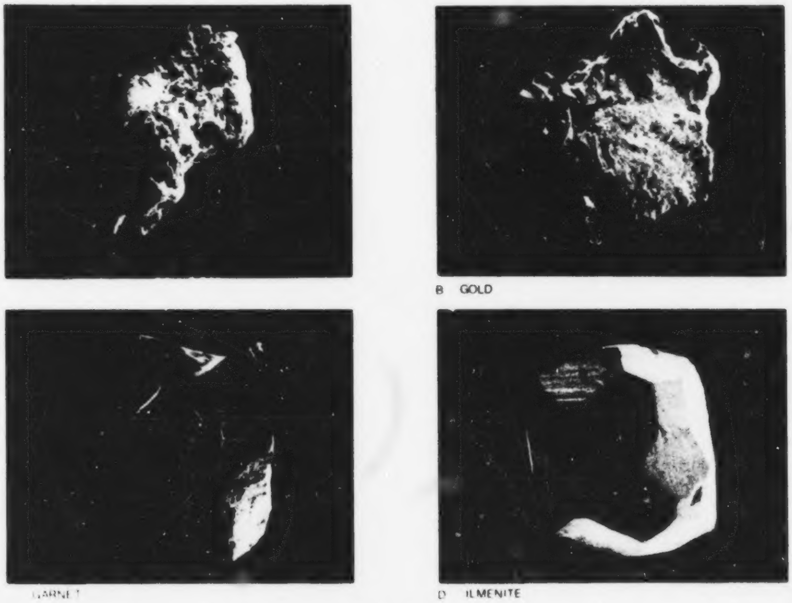


Figure 2. (A) Example of a gold nugget.
(B) Example of a gold flake. Note slender, delicate extensions at grain edge indicating minimal deformation during transport.
(C) Euhedral garnet crystal. Note the sharp contact between crystal faces indicating minimal abrasion during transport.
(D) Example of an ilmenite grain.

GENERAL GEOLOGY

The Forest Hill Gold District, like all of the gold deposits of mainland Nova Scotia, is hosted by rocks of the Cambro-Ordovician Meguma Group. This Group underlies most of mainland Nova Scotia south of the Glooscap Fault. The Meguma Group has been divided into two formations. The basal Goldenville Formation consists of ≈7 km of sandy turbidites and is conformably overlain by ≈6 km of black slates known as the Halifax Formation (Schenk, 1971, 1978). The auriferous quartz veins occur mainly in the upper part of the Goldenville Formation (McBride, 1978; Henderson, 1983).

Deformation during the Devonian Acadian Orogeny resulted in the formation of northeastward-trending anticlines and synclines. The anticlinal axes, which are on average 5 km apart and from 10 km to 160 km long, plunge to the east and west at numerous locations to form dome shaped structures. The domes are commonly associated with zones of gold enrichment and characterize many of the known gold deposits in the Meguma Group (Faribault, 1913).

LOCAL GEOLOGY

At Forest Hill the Goldenville Formation narrows to an east-west trending lens which separates two large masses of Devonian granites. The rocks of the area have been metamorphosed to amphibolite facies and are extensively fractured and faulted. Numerous granitoid dykes are intruded into the host rocks which are altered to andalusite, staurolite and garnetiferous schists (Malcolm, 1976).

PLEISTOCENE GEOLOGY

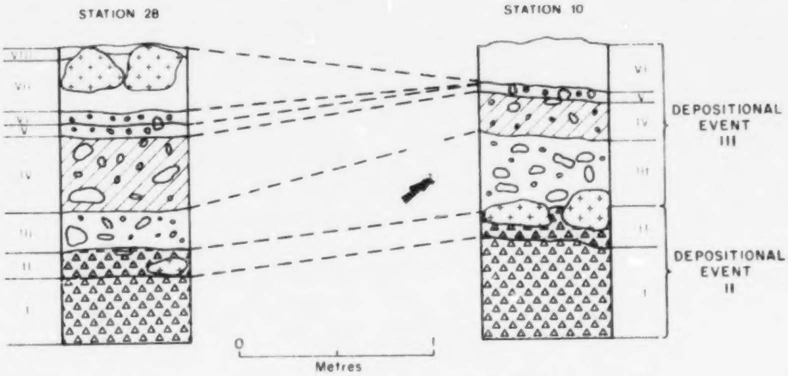
GENERAL STATEMENT

In the eastern Meguma Terrane, bedrock striations and roches moutonnées indicate a major period of southeastward ice flow (140°-160°). A till sheet associated with the southeastward flow has been recognized in the area (Stea and Fowler, 1979). This till is a loose to moderately compact sandy unit, which demonstrates rapid transitions in lithological facies across bedrock contact zones. In some areas an extensive melt-out phase is developed forming hummocky terrain. A regionally consistent striation set trending 180° cuts the southeastward trending striations. Pebbles of fossiliferous sandstone, Silurian and volcanic rocks along the Eastern Shore, and southwestward trending eskers attest to a period of ice flow that crossed or stemmed from the Antigonish Highlands (Stea and Fowler, 1979). In the Forest Hill area this ice flow, which transported Antigonish Highland erratics, was probably due south. Southeastward and southward trending striations were mapped at Forest Hill (Fig. 1).

TILL STRATIGRAPHY

Figure 3 illustrates a stratigraphic correlation of two trench sections (stations 10 and 28) from Forest Hill. The two younger tills are well exposed at these stations. The lower till is olive-brown and moderately compact. The matrix varies from medium sand to fine sand and silt.

The fabric of the lower till is relatively consistent over the study area and generally parallels the direction of bedrock striations (150°). This is overlain by a reddish-brown to dark yellowish-brown layer 10 cm to 15 cm thick. This zone is found throughout the area and is best developed at station 10. Within and on top of this zone is a layer of granite cobbles and boulders. The reddish colour appears to coat the grains and there are many small rootlets throughout the unit. Overlying the zone is the youngest till. It is a greenish to yellowish-brown unit characterized by a coarse sand matrix. The genesis of this till is uncertain. It resembles a melt-out till, however, at some locations it has been shown to closely reflect the underlying bedrock and possess a strong



VIII - Humus layer (L)

VII - Leached soil layer (Ae)

VI - Dark brown cemented soil (Bhf)

V - Dark orange brown soil (Bf)

IV - Orangy-yellow layer of altered till

III - Bleached till, coarse sand matrix

II - Yellowish-brown layer (paleosol?) fine sand/silt matrix

I - Olive-brown till, fine sand/silt matrix compact

VI - Slumped material

V - Orange-brown soil (Bhf)

IV - Altered till, orange-yellow colour

III - Greenish-brown till, coarse sand matrix very loose, unconsolidated

II. Yellowish-brown layer, fine sand/silt matrix (paleosol?)

I - Olive-brown till, medium sand matrix compact

Figure 3. Till stratigraphy at Forest Hill. Stations 10 and 28 show depositional events two and three.

unidirectional clast fabric. The clasts in this till are generally angular and unabraded, but some are faceted and striated parallel to their long axes; this is characteristic of the lodgment process.

The fabric of the upper till trends northeast-southwest (250°), and is normal to the regional southeastward ice movement. The presence of a few scattered bedrock striations trending 180°-250° supports the concept that a south-southwest ice movement deposited the upper till unit.

The till stratigraphy of station 121 is shown in Figure 4. At this location the oldest till is exposed. It is a washed, gravel-sand unit that is poorly cemented and exhibits Fe-Mn oxide staining and MnO_2 coated clasts. It is thickest at the northern end of the section and wedges out to the south as the drift package thickens. Overlying the gravel is an olive-grey, moderately compact sandy till that contains sand lenses. This unit pinches out to the north into a sand zone and increases to the south to form most of a large hummock 3 m to 4 m thick. On top of the sandy till is a reddish-brown zone, 10 cm to 15 cm thick, that contains many small red-rootlets. This unit, interpreted as a paleosol, comes to the surface toward the southern end of the section. Chemical analyses of samples from

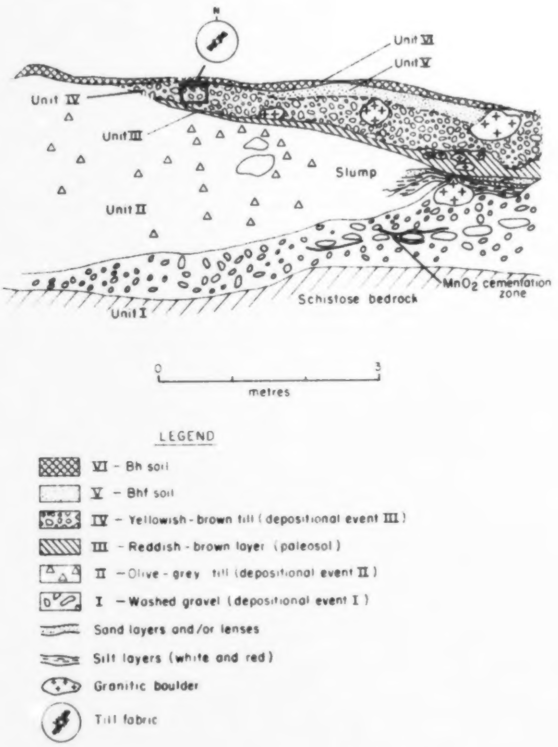

N
Unit VI
Unit V
Unit IV
Unit III
Unit II
Slump
Unit I
Schistose bedrock
MnO2 cementation zone
0
3
metres
LEGEND
VI - Bh soil
V - Bhf soil
IV - Yellowish-brown till (depositional event III)
III - Reddish-brown layer (paleosol)
II - Olive-grey till (depositional event II)
I - Washed gravel (depositional event I)
Sand layers and/or lenses
Silt layers (white and red)
Granitic boulder
Till fabric

Figure 4. Complex till stratigraphy as seen at station 121. Three major depositional events are indicated.

this zone support the contention that it is a remnant soil (D. Holstrum, personal communication, 1983). Relative to both the underlying and overlying tills the zone is enriched in organic carbon, iron and aluminum. Values obtained for the paleosol closely reflect those obtained from the corresponding modern B-horizon (Table 1). Overlying the reddish paleosol is an yellowish-brown loose sandy till containing many granite boulders and exhibiting a strong till fabric striking 230°. This till unit ranges up to a metre in thickness. A boulder embedded within this unit with a long/short axis ratio of greater than 3:1 was found to trend 230°.

GOLD DISTRIBUTION

Figure 1 depicts the sample sites, glacial features, and gold dispersion at the study area. Results from the systematic panning of the till units show that visible gold is usually confined to the basal unit in

Table 1. Analyses of four surficial units at station 10 (westernmost trench), Forest Hill Gold District, Guysborough County, Nova Scotia. Note the similarity in chemical values obtained for the modern B-horizon soil and the "reddish-brown layer" interpreted as a paleosol. Particle size distribution figures indicate that the matrix textures of the units are dominated by sand and silt.

Sample No.	Description	Ammonium Oxalate			Sodium Pyrophospate		Particle Size Distribution %							
		%C	%Fe	%Al	%Fe	%Al	Total sand	2-1 mm	1-.5 mm	5-.25 mm	.25-1 mm	.1-.05 mm	Silt	Clay
06-83	Modern Bh soil	0.92	0.29	0.61	0.15	0.36	67.4	11.7	11.1	7.7	16.8	20.0	31.0	1.6
07-83	Unaltered till (depositional event 11)	0.21	0.11	0.18	0.04	0.13	62.3	14.5	11.7	8.0	13.8	14.3	34.6	3.0
08-83	"Reddish-brown layer" (paleosol)	0.96	0.33	0.69	0.08	0.43	60.2	11.3	10.9	6.7	15.9	15.4	35.6	4.2
09-83	Unaltered till (depositional event 1)	0.23	0.19	0.29.	0.04	0.14	61.7	13.3	11.9	7.7	13.7	15.5	34.0	4.3

areas of high bedrock topography and is present throughout most units, including soils, in topographically depressed areas.

The lateral dispersal of visible gold in the till is predominantly down-ice in a southeastward direction from known auriferous veins, illustrating the mechanical dispersal of gold. There are, however, several areas of rich drift which cannot be explained in this way. These may be indicative of postglacial dispersal processes or mechanical dispersal from undiscovered auriferous veins. The inferred southwestward flow event does not seem to have substantially redistributed the visible gold, evidenced by the lack of panned gold in the westernmost trench.

CHARACTER OF THE GOLD

Gold in the till occurs as both small flakes and small nuggets. Examination of grains with a scanning electron microscope shows the grain surfaces to be rough and pitted and exhibiting little evidence of deformation indicative of abrasive glacial transport. This is also true of the other minerals which comprise the heavy mineral suite including garnet, ilmenite and titanoferrite.

Photomicrographs of gold and heavy minerals recovered from panned concentrates are shown in Figure 2. Magnification and bar scales are shown on the individual photos.

SUMMARY

The till stratigraphy at the Forest Hill area is complex. There is evidence for three major depositional events. The oldest event is represented by an oxidized and poorly cemented washed gravel unit preserved only in areas of topographic depression. The second event, a regional southeastward ice movement, deposited a moderately compact, olive-brown till. A reddish to yellowish-brown paleosol is developed in this till indicating a period of climatic warming and ice retreat. The final depositional event is represented by a yellowish-brown, loose, sandy till associated with a southwestward ice advance.

The gold dispersion in the study area generally reflects the regional southeastward ice-flow direction from known auriferous veins. Several areas of gold-rich drift cannot be explained in this way and may be manifestations of postglacial processes or glacial dispersion from undiscovered auriferous veins.

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MEGUMA GOLD PROJECT, EASTERN MEGUMA TERRANE, NOVA SCOTIA

J. D. Keppie

INTRODUCTION

This project is part of the Canada-Nova Scotia Co-operative Mineral Program (CNSCMP) 1981-84. It is a multidisciplinary study of the area east of longitude 62°30'. J. R. Henderson (Geological Survey of Canada) along with U. Kretschmar, J. H. Crocket, P. M. Clifford, F. Fueten, A. Kabir, R. A. Stern, M. Henderson, and student assistants have mapped the area between 62°00' and 62°30', with specialist studies in certain areas. J. W. F. Waldron and L. Jensen have undertaken a ground gradiometer survey, combined with stratigraphic/sedimentological studies, in the coastal areas between Taylor Head and Indian Harbour. J. D. Keppie, S. J. Haynes, B. H. O'Brien, P. K. Smith, M. Sommer, R. Yonover, R. Farquhar, D. Dallmeyer, T. E. Krogh, G. K. Muecke, G. A. O'Reilly, and L. Ham have studied various aspects of the geology in the area east of 62°00'. I. J. MacEachern, R. R. Stea and P. J. Rogers have examined the till stratigraphy and geochemistry in the Forest Hill Gold District. M. Zentilli has examined the stratabound lead deposit at Eastville. The area between 61°30' and 62°30' was surveyed by the Geological Survey of Canada using an airborne gradiometer/VLF-EM (Hertz Industries BTRI Totem 2A) and the whole area was covered by a Geological Survey of Canada radiometric survey.

Preliminary results of some of the studies are published in the following: Geological Survey of Canada *Papers 83-1A and 83-1B;* Nova Scotia Department of Mines and Energy *Report 83-1;* and the Canadian Institute of Mining and Metallurgy Field Guidebook *Gold Deposits in the Meguma Terrane of Nova Scotia, 1983.*

STRUCTURAL STUDIES IN GREENSCHIST FACIES ROCKS, MEGUMA GROUP, SOUTHWESTERN GUYSBOROUGH COUNTY*

B. H. O'Brien

During 1983, the writer completed fieldwork on the Meguma Gold Project. Field investigations were aimed at extending the 1982 structural database (O'Brien, 1983a). Detailed studies of Meguma Group rocks at chlorite and biotite grades were made in selected areas of southwestern Guysborough County.

METASEDIMENTARY ROCKS

Metasedimentary rocks were examined at Sherbrooke, Indian Harbour and Gegogan Harbour to further elucidate the nature of S_s cleavage (O'Brien, 1983a). On the Isle of Rae and on the shoreline of Gegogan Harbour immediately north of Coote Head (Fig. 1), gently dipping S_s grain alignment cleavage and steeply dipping S_g pressure solution cleavage are present in vertical sandstone beds. S_s cleavage is not ubiquitous, but in places it is strongly developed. Minerals defining the S_s cleavage are reduced in grain size within the steeper, crosscutting S_g pressure solution seams. Where seams are widely spaced and anastamosing, S_s is found as an intralithon foliation inclined at various angles to S_g. In the centre of massive sandstone beds, where the rocks are least affected by D_g strain, S_s cleavage is locally normal to bedding. Near bedding planes, especially those separating shale interbeds, S_s cleavage becomes parallel to bedding as a result of F_g flexural slip. Along the footpath leading to the Sherbrooke radio tower, S_s is observed to be axial planar to parasitic, subrecumbent folds of bedding on the steep limb of small stepfolds.

VEIN ARRAYS

Vein arrays of variable morphology and composition were studied in greenschist facies host rocks at Wine Harbour, Gegogan Harbour, Isaacs Harbour, Mill Cove on the St. Marys River, Triford Head, and particularly, Country Harbour Head (Fig. 1). Arrays displaying distinct, characteristic features are to be found within and outside established gold districts.

Polymineralic quartz veins occupy fractures in altered host rocks. They were emplaced before, during, and after the development of the regional slaty and pressure solution cleavages (S_g). From field observation it is evident that some arrays formed when the strata were horizontal, while others were produced when the beds had acquired a strike and dip through folding and faulting. Regardless of the relative time of emplacement, all vein-types are seen to crosscut bedding, although some more obviously than others.

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*Contribution to Canada-Nova Scotia Co-operative Mineral Program 1981-84. Project carried by Nova Scotia Department of Mines and Energy and Geological Survey of Canada.

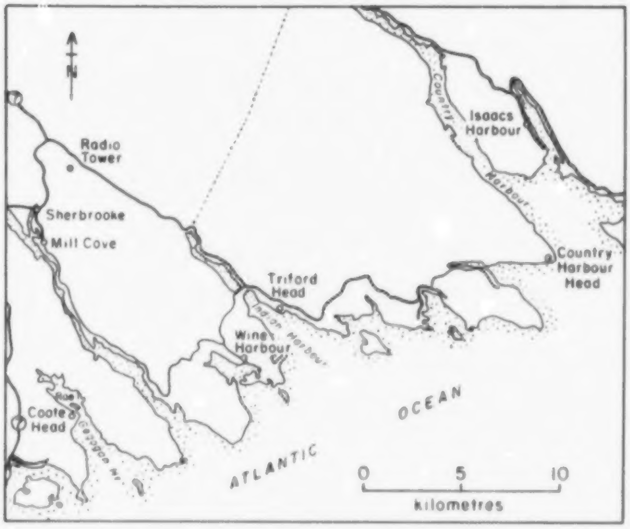
N
Radio Tower
Sherbrooke
Mill Cove
Triford Head
Indian Harbour
Wine Harbour
Country Harbour
Isaacs Harbour
Country Harbour Head
Coote Head
Gegogan Hr.
OCEAN
ATLANTIC
0
5
10
kilometres

Figure 1. Location map of study area, southwestern Guysborough County, Nova Scotia.

Stratigraphically transgressive vein arrays are found in contact with one another in many of the study areas mentioned. Two types of contact relationships are observable: crosscutting and abutting. Crosscutting veins consistently giving the same relative age sequence generally fall into pre-S_g and post-S_g arrays. Synfolding and syncleavage veins locally crosscut each other, but their order of emplacement is not predictable.

Abutting relationships between vein-filled fractures are common in southwestern Guysborough County. Here, however, they cannot be used to unequivocally establish relative ages. Abutment seems to have occurred where intersecting cracks were once contemporaneously dilatant. Crosscutting relationships presumably imply that, at the time of intersection, a dilating crack transected an already sealed fracture (e.g. Gretener, 1969). If the charged fluid, which filled and opened(?) the cracks crystallized between 265°C and 430°C (Haynes, 1983; Graves and Zentilli, 1982), and if brittle failure occurred at depths between 5 to 15 km, then syndeformational shear and tensile fractures could be expected to have acted intermittently as hydraulic fractures.

Many of the veins in the area provide a textural record of the extensional strain during regional deformation, through such affects as curved fibres. Some have been related dynamically and kinematically to folding and faulting processes (O'Brien, 1983b).

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GOLDENVILLE FORMATION, EASTERN SHORE, NOVA SCOTIA: STRATIGRAPHIC CORRELATION AND PRELIMINARY SEDIMENTOLOGICAL RESULTS*

J. W. F. Waldron** and L. R. Jensen**

ABSTRACT

The Cambro-Ordovician Goldenville Formation consists of repetitively interbedded slates and metamorphosed poorly sorted sandstones which have been previously interpreted as turbidites. Measurements of vertical magnetic gradient over well-exposed coastal sections allow recognition of marker horizons which can be traced laterally. We have subdivided a package 2.5 to 3 km thick into about 15 units, some of which have been traced 15 km along strike and across the Sober Island Syncline.

Measured sections in the correlated units show major lateral facies changes, including crosscutting erosional contacts at the base of sandstone-dominated packets. Vertical sequences show both thinning- and thickening-upwards trends. A preliminary classification of sediments into seven facies has been adopted. These indicate a variety of depositional mechanisms. Further work on the distribution of facies should lead to an improved understanding of the depositional system.

INTRODUCTION

The Goldenville Formation forms the lower part of the Cambro-Ordovician Meguma Group, which underlies most of southern mainland Nova Scotia. The Goldenville Formation, together with the overlying Halifax Formation, is folded in upright, open to tight subhorizontal folds trending in an arcuate pattern from almost north-south in western Nova Scotia to east-west in the east. The Goldenville Formation is at least 5600 m thick, and consists of grey metamorphosed sandstones with subordinate interbedded greenish slates. Its base is nowhere exposed. The formation has resisted all attempts at regional stratigraphic subdivision because of its lithological uniformity and the lack of fossils.

The Goldenville Formation is particularly well exposed in the area shown in Figure 1, where Harris (1971) was able to trace certain beds along strike between Phoenix Island and Taylor Head. We have been able to extend this correlation both laterally and vertically, using a vertical gradient magnetometer to identify marker horizons, and have carried out a sedimentological field investigation based on these results. Interpretation of the data in this investigation is still in progress; in this report we discuss the geophysical correlation techniques and briefly describe the principal sedimentary facies present. We do not here propose any comprehensive model for the depositional system, since a large volume of data collected in the 1983 field season remains to be analyzed.

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*Also *in* Current Research, Part A, Geological Survey of Canada, Paper 84-1A, p. 147-155, 1984.
Contribution to Canada-Nova Scotia Co-operative Mineral Program 1981-84. Project carried by Geological Survey of Canada.

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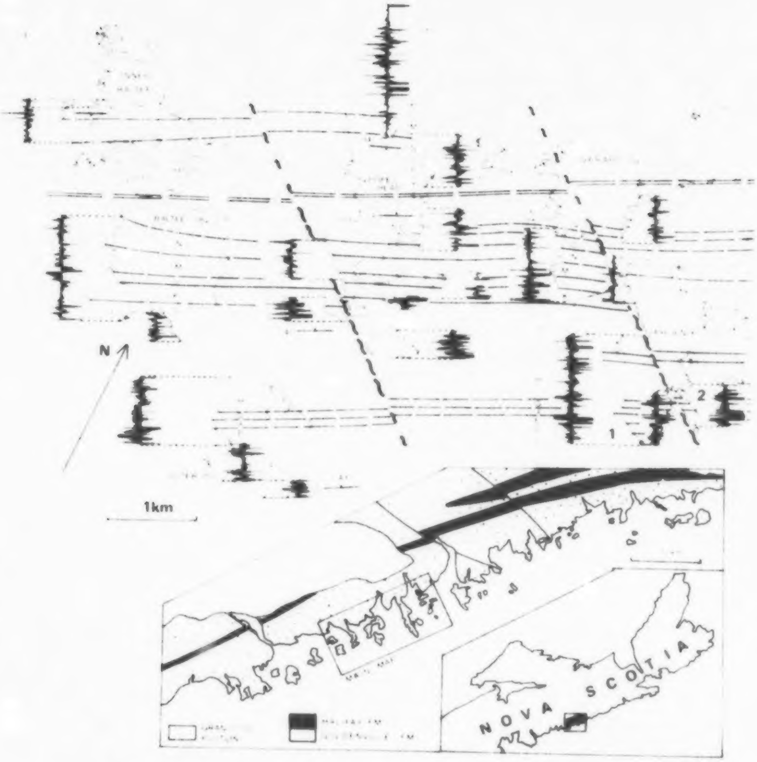
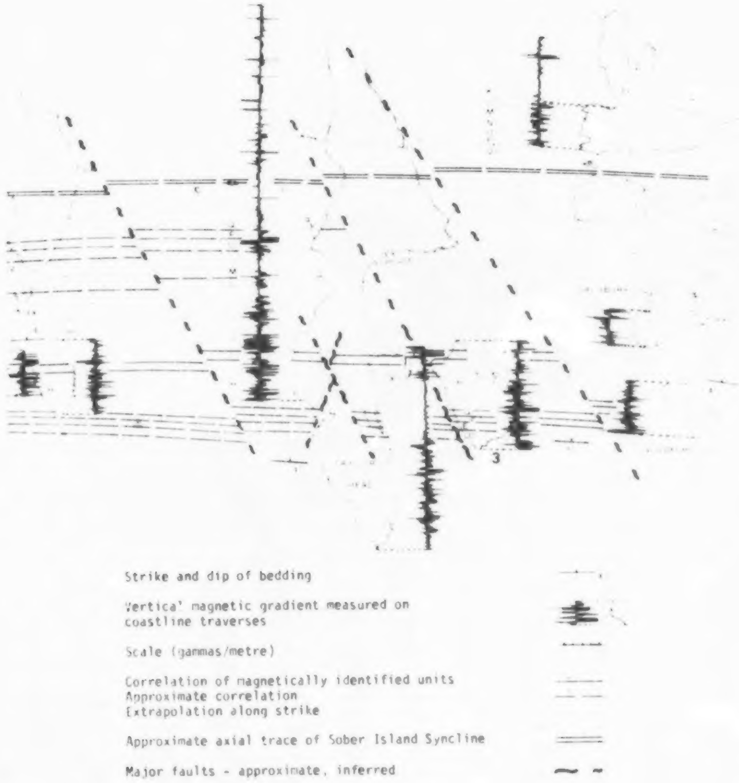


Figure 1. Map of area densely covered by vertical gradient magnetometer traverses, showing proposed correlations and inferred extent of magnetically characterized subdivisions C to Q. Strike of boundaries taken from airphotographs, field measurements, and locally in the core of Sober Island Syncline from Harris (1971). Many minor faults not shown. Numbers indicate location of measured sections shown in Figure 3.


3
Strike and dip of bedding
Vertical magnetic gradient measured on coastline traverses
Scale (gammas/metre)
Correlation of magnetically identified units
Approximate correlation
Extrapolation along strike
Approximate axial trace of Sober Island Syncline
Major faults - approximate, inferred

GENERAL GEOLOGY

The Goldenville Formation in the area of Figure 1 consists predominately of grey to greenish-grey poorly sorted fine- to medium-grained sandstones in which an originally clay-rich matrix is altered to metamorphic chlorite. There are occasional coarser sandstones and granule conglomerates. The sandstones occur in beds from 1 cm to several metres thick, although amalgamated packages may be over 50 m thick. The sandstones show a variety of sedimentary structures including sole-marks, abundant parallel lamination, various types of cross stratification, bioturbation, and water-escape structures. Interbedded greenish slates make up less than 30 per cent of the sequence. They show parallel and crosslaminations, though some appear devoid of primary structures. A major syncline (the Sober Island Syncline) runs through the northern part of the area (Fig. 1). Slaty cleavage in the finer grained sediments and a sporadic spaced pressure-solution cleavage (Henderson, 1983; O'Brien, 1983) in the sandstones appear axial planar to this fold; they increase in intensity towards its axial trace.

The shapes of deformed sand volcanoes suggest a strain ratio in the plane of bedding of around 2:1 on the limbs of the fold, with the long axis of the strain ellipse parallel to the bedding-cleavage intersection lineation. However, the volcanoes may underestimate the true strain if they deform inhomogeneously with their generally finer grained matrix. The sediments are cut by several generations of quartz veins, some of which are parallel to the bed. Haynes (1983) suggested a sedimentary origin for some bed-parallel veins farther east; however, the veins observed by us were sharply bounded and showed no mixing with argillaceous sediment or other evidence for a seafloor origin. A set of northwest trending faults is present in the area (Fig. 1). Many of these can be seen on airphotographs. They consistently appear to have a major sinistral strike-slip component of movement.

PREVIOUS SEDIMENTOLOGICAL WORK

The Goldenville Formation was named by Woodman (1904a), who interpreted the formation as a product of a turbulent shallow-marine depositional environment, and remarked (1904b) upon the lateral discontinuity of the sandstone layers. Phinney (1961) was the first to propose a deep-marine, turbidite origin for the sandstones. Subsequently Campbell (1966) identified a predominant northeastward paleocurrent direction in the formation, and postulated deposition in a deep-sea trough. Schenk (1970) systematically studied the entire Meguma Group using a grid sampling system, and proposed that turbidity-current deposits had been extensively reworked by contour-following bottom currents. Harris (1971), in a study of the Taylor Head area (Fig. 1) described the various sedimentary structures in detail and postulated deposition mainly by turbidity currents. Schenk (1973) compared the Meguma sediments with recent abyssal plain deposits of the western North Atlantic, whereas Harris and Schenk (1975) equated the facies of the Goldenville Formation with mid-fan deposition in the submarine fan model of Walker and Mutti (1973), and suggested grain-flow and fluidized-flow as possible depositional mechanisms in addition to turbidity currents.

GEOPHYSICAL WORK

Previous sedimentary studies in the Goldenville Formation have been hampered by the lack of marker horizons in the thick sequence of monotonous sandstones and slates. Stern and Henderson (1983) carried out a magnetic survey at ground level of a part of the formation, and showed that measurements of the vertical gradient of the total field could define stratigraphically controlled anomalies with sufficient resolution to permit tracing of individual sand packages along strike. We have used this method to subdivide and correlate within a package about 3 km thick on the south limb of the Sober Island Syncline. The correlation has so far been extended about 15 km along strike between Salisbury and Baltee islands (Fig. 1). We have also correlated this package with outcrops to the north of the Sober Island Syncline.

METHODS

Lines for magnetic surveying were laid out using a Brunton compass and survey tape. Lines were selected along well exposed coastlines and where possible were oriented perpendicular to the local strike of bedding. Strike-parallel offsets were used to accommodate irregularities in the coastline wherever practical; elsewhere, lines oblique to strike were used. No elevations were surveyed, since survey lines were predominantly in coastal areas with a vertical relief of generally less than 5 m. To facilitate correlation of magnetic anomalies with individual beds, tie-in points were marked at 20 m intervals along the survey lines.

An EDA-instruments PPM-500 vertical gradient magnetometer was used to measure total field and vertical gradient at 2 m intervals along the survey lines. The results were plotted during the field operation, using an HP85 desk-top computer at the field camp.

The vertical gradient magnetometer consists essentially of two total-field proton magnetometers mounted 1 m apart in a single vertical pole. The value recorded is the difference (in gammas) between the two total field values. Compared with a conventional magnetometer the instrument emphasizes the magnetic effects of near-surface bodies and steeply dipping layers, and is thus particularly suited to differentiating exposed units which differ in their magentization but are outwardly lithologically uniform. Under such circumstances the instrument can resolve anomalies separated horizontally by as little as 5 m. The amplitude of the anomalies falls rapidly with distance from source, so that traverses across overburden produce relatively flat profiles, as for example along the barrier beach on the east coast of Taylor Head (Fig. 1). Even in such intervals, however, the resolution provided by the vertical gradient is found to be superior to that of the total field data, although the reduced amplitude makes correlation more difficult.

It was found that adequate correlation in the area of Figure 1 could be achieved with fairly closely spaced (1-3 km) traverse lines, but that it was first necessary to use airphotographs to determine strike and locate major faults. In less well exposed areas a much denser spacing of survey lines would be needed for unambiguous correlation. No correction could be made for the effect of topography, which undoubtedly influenced some readings. When positive features coincided with steep topographic slopes, a large adjacent negative anomaly was frequently recorded, whereas large negative gradients were rare on level ground. The results thus contain effects of local topographic features, which modify the shapes and amplitude of some anomalies. No attempt has been made, therefore, to model the magnetic properties of individual layers, which would require precise topographic surveying along and adjacent to the traverse lines.

RESULTS

Figure 1 shows the variation in vertical magnetic gradient on across-strike profiles in the region between Salisbury and Baltee islands, where a package of the Goldenville Formation about 2.5 km thick is particularly well exposed. The top of this package lies about 1.5 km below the top of the Goldenville Formation according to the cross-section of Harris (1971). A number of conspicuous features on the magnetic profiles can be correlated between profiles, allowing subdivision of the package on the southern limb of the Sober Island Syncline into about 15 stratigraphic units, as shown in Figure 1. Correlation with the northern limb of the Syncline is more tentative; the profile on Taylor Head has low amplitude due to overburden, and is interrupted by spurious peaks due to metal stream culverts. Probable correlation is, therefore, shown only for two traverses to the east and west of Taylor Head. Outcrops were found to be relatively poor on south-dipping fold limbs throughout the area studied, possibly owing to the plucking effects of south-flowing ice during glaciation.

Figure 2 shows a vertical gradient profile from the east coast of Phoenix Island (Fig. 1) plotted against height in the stratigraphic section. A graphic log of the corresponding interval is shown alongside for comparison. Large positive gradients are clearly associated with packages of thickly bedded sandstone. This supports Stern and Henderson's (1983) attribution of the magnetic anomalies to a detrital component (magnetite) in the sandstone. Nevertheless, some thick sandstones do not correspond to major peaks; the magnetic profiles cannot, therefore, be used to map lithologies or facies directly.

The correlation of vertical gradient profiles provides good control of the apparent offset of a number of faults, most of which can be accurately located on airphotographs. Note also that small thickness changes can be seen in some units as they are traced along strike; in general, it is not possible to determine whether these variations are primary or tectonic in origin, but the disappearance of a conspicuous interval of negative gradients west of Phoenix Island is almost certainly the result of localized erosion prior to the deposition of a large lenticular sand body.

SEDIMENTOLOGY

METHODS

Stratigraphic sections were measured layer-by-layer along all gradiometer survey lines (Fig. 1) that crossed continuous or near-continuous coastal outcrop. These sections totalled about 8 km in aggregate stratigraphic thickness.

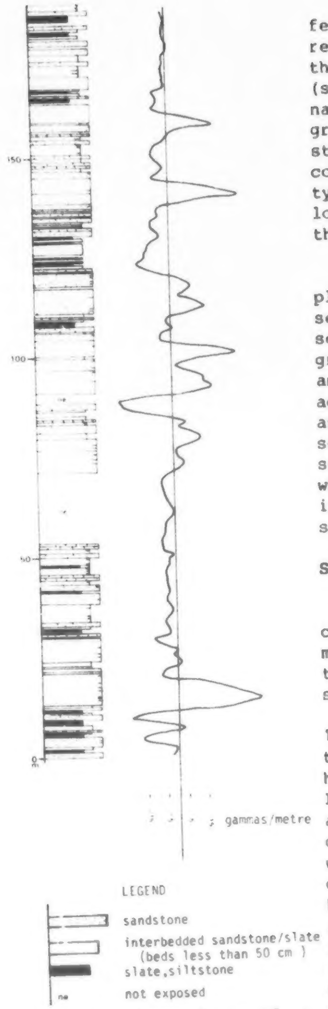


Figure 2. Comparison of a portion of the stratigraphic log and vertical gradient profiles, east coast of Phoenix Island.

For each layer the following features were recorded on specially devised recording forms: thickness, whether thickness varied significantly, lithology (sandstone, slate, intermixed, quartz vein), nature of basal surface (sharp or gradational), and a list of sedimentary structures present. A program for the HP85 computer was written to accept these data typed in at the keyboard and to plot graphic logs of the sections measured, initially at the scale of 1:500.

Following lateral correlation using plots of vertical magnetic gradient, certain segments of the stratigraphic sequence were selected for detailed study. Computer-drawn graphic logs at a scale of 1:50 were annotated in the field with the following additional information: estimated average and maximum grain size, description of all sedimentary structures in their vertical sequence, sorting and roundness of grains where visible, direction of paleocurrents indicated by flutes, grooves and other sedimentary structures.

SEDIMENTARY FACIES

We have adopted a preliminary classification of the sediments into seven main types. Typical examples of most of these are identified in Figure 3 and are shown in field photographs (Figs. 4 to 8).

1. **Intraclast conglomerate** (Fig. 4). This type of sediment is restricted to a few horizons within the sequence investigated. It consists of predominantly angular argillaceous clasts ranging from a few centimetres to 2 m in length, within a matrix which varies from medium sandstone to granule conglomerate (Fig. 4). Tectonic deformation has caused the clasts to flatten considerably and the matrix in some instances to be folded. The beds range from 3 to 10 m in thickness and are associated with thick massive and crosslaminated sandstones. Internal sedimentary structures are rare, with the clasts being scattered homogeneously throughout the bed. Some "rafts" of laminated coarse to very coarse sandstone (up to 0.2 m thick) are found on Taylor Head within the lower portion of one such bed.

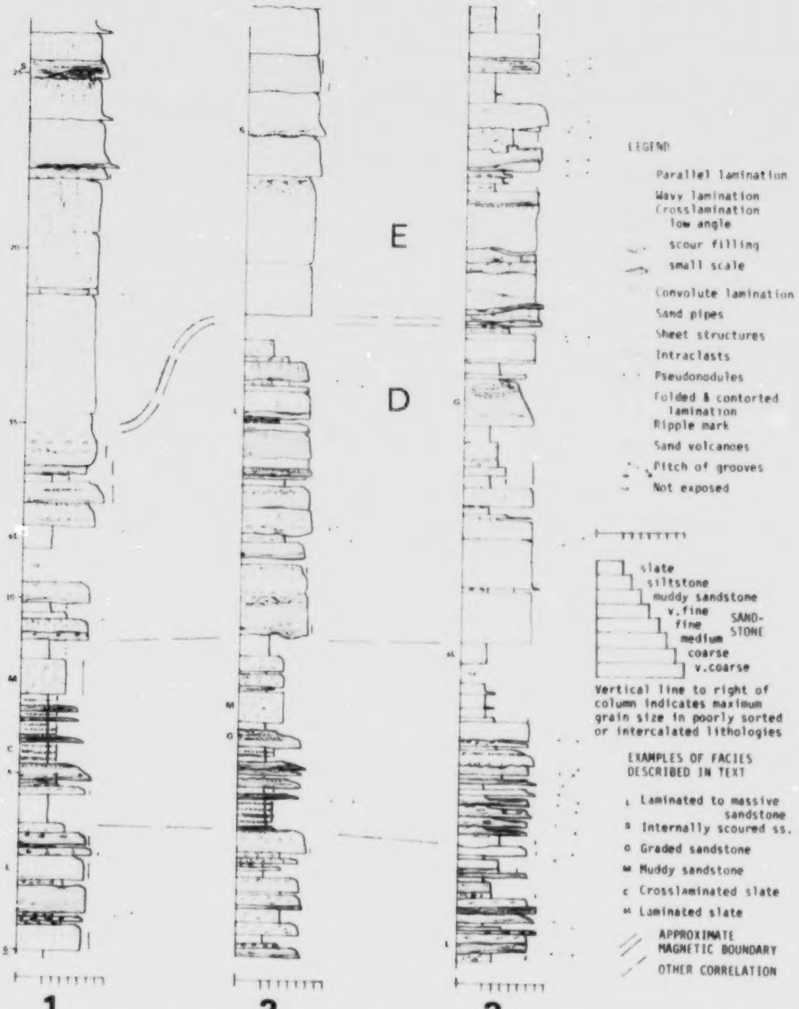

E
D
LEGEND
Parallel lamination
Wavy lamination
Crosslamination
low angle
scour filling
small scale
Convolute lamination
Sand pipes
Sheet structures
Intraclasts
Pseudonodules
Folded & contorted lamination
Ripple mark
Sand volcanoes
Pitch of grooves
Not exposed
slate
siltstone
muddy sandstone
v.fine
fine
medium
coarse
v.coarse
SAND-STONE
Vertical line to right of column indicates maximum grain size in poorly sorted or intercalated lithologies
EXAMPLES OF FACIES DESCRIBED IN TEXT
L Laminated to massive sandstone
S Internally scoured ss.
G Graded sandstone
M Muddy sandstone
C Crosslaminated slate
H Laminated slate
APPROXIMATE MAGNETIC BOUNDARY
OTHER CORRELATION
1
2
3

Figure 3. Three laterally equivalent sections across the boundary between magnetic units "D" and "E", illustrating lateral variations in bed thickness and sedimentary structures. Examples of sediment types mentioned in the text are indicated by small letters to the left of the columns. Locations of sections 1, 2 and 3 are marked in Figure 1.

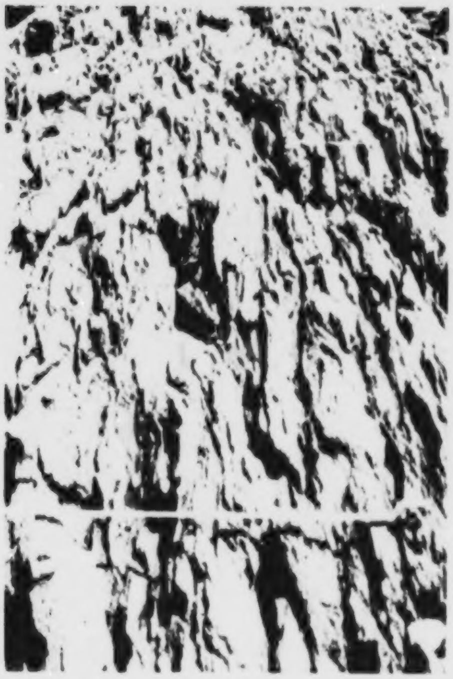


Figure 4. Flattened intraformational conglomerate: angular slate clasts (dark) surrounded by a matrix of very coarse sand and granule-size material. Outer Island. Scale is 1 m.

The argillaceous clasts appear lithologically similar to slate beds occurring elsewhere in the sequence, and are thought to be products of intrabasinal erosion.

2. **Internally scoured sandstones** (Figs. 3, 5, 6). These sandstones commonly occur in amalgamated packages, within which recognizable depositional units range from 2 to 10 m in thickness, averaging around 3.5 m. The most characteristic sedimentary structures are large flute-like scour structures typically around 0.15 m deep, 0.35 m wide and 0.8 m long. These are filled with crosslaminated sandstone as shown in Figure 5; the crosslaminations typically "feather-out" down-current (generally towards the east). Locally a single scoured surface is seen to climb within a sandstone layer from west to east; elsewhere numerous localized scours are present at different levels. The crosslaminated sands are invariably coarser grained than sediments above and below, often containing very coarse sand or granule laminae immediately above the scour surface.

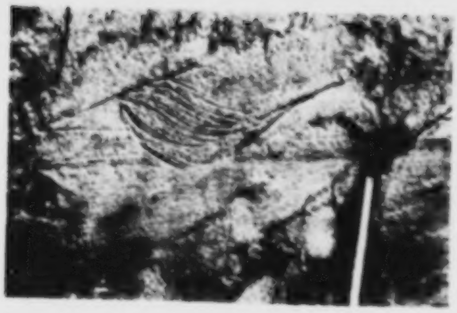


Figure 5. Internally scoured sandstone: parallel lamination passing upward into crosslaminated scour depressions. Gerard Island. Scale is 0.30 m.

Figure 6. "Nested" flute marks showing internal crosslamination, occurring within internally scoured sandstones. Gerard Island. Matchbook (lower centre) for scale.

Scours are not usually developed throughout a sand layer. Frequently the scoured portion overlies generally finer, parallel- or wavy-laminated sandstone (Fig. 5) which may show inverse grading near the base of the layer. Above the scoured interval crosslamination usually gives way in turn to wavy lamination, parallel lamination, and/or massive sandstone with abundant dewatering pipes and sheets, and occasional vertical burrows. Grading is confined to the top few centimetres. Sand volcanoes or ripple marks may be developed at the top surface.

The internally scoured sandstones were clearly rapidly deposited by fast-flowing currents. Multiple scours imply repeated erosion and deposition, suggesting that major fluctuations in current velocity occurred within each episode. Pipe and sheet structures, and sand volcanoes were produced after deposition as a result of water-escape from loosely packed sand.

3. **Laminated to massive sandstone** (Figs. 3, 7). This is the most common type of sandstone found in the area. The beds range from 0.4 to 3.0 m thick with a typical thickness around 0.8 m. They consist mainly of fine to medium sandstone with grading confined to the top few centimetres. The lower contacts are sharp, with frequent tool marks and rarer flutes indicating eastward paleocurrents. Rarely, a thin layer of very coarse sand to granule size sediment is present within the tool marks. Typically such beds may be divided into two portions. The lower portion, about one third of the total thickness, is characterized by parallel to wavy laminations, low-angle crosslaminations, or rarely by massive sandstone. The laminations sometimes show curving, convex-

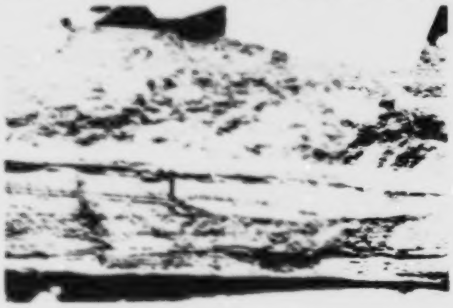


Figure 7a. Laminated to massive sandstone with wavy lamination in basal portion succeeded by a vaguely parallel-laminated to massive unit with inclined sand pipes. Phoenix Island. Pencil (centre) is 14 cm long.

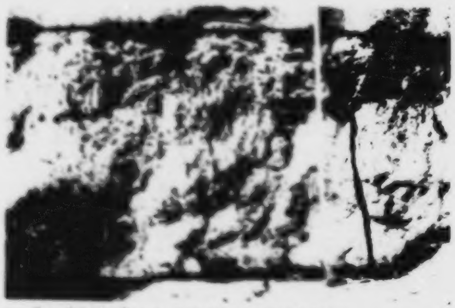


Figure 7b. Laminated to massive sandstone. The lower portion of the bed is parallel-laminated. Abundant sand pipes occupy the upper portion. Pale lumps at top of bed are sand volcanoes seen in cross-section. Gerard Island. Scale is 1 m long.

upward shapes. Conspicuous parting surfaces may be present. The upper portion (usually about two thirds of the bed) is usually massive, but contains vertical or steeply inclined pipes or sheets of slightly coarser, better sorted sand. More rarely this interval shows convolute lamination or pseudonodules, parallel lamination and/or dish-structures, and mudstone intraclasts. Sand volcanoes are common on the top surface.

Laminated to massive sandstones again indicate rapid deposition under high energy conditions. Homogenization of the upper parts of the beds was primarily due to water escape.

4. **Graded sandstones** (Fig. 3). Sandstone beds showing continuous grading from base to top are less common in the sections studied than the above two types, being frequent only in muddy intervals between large sand packets. Bed thicknesses range from 0.05 to 1.0 m, but are typically 0.2 m. The sandstones are usually parallel laminated and pass up into ripple-drift crosslaminated silts. Their sequences of sedimentary structures can be accommodated within the Bouma (1962) sequence, characteristic of "classical" turbidites.

5. **Muddy sandstones** (Fig. 8). This category includes a range of sediment types characterized by the presence of very poorly sorted, highly cleaved muddy sandstone. Within this sediment, fine sandy and shaly laminae are often highly contorted, probably as a result of slump folding (Fig. 8). Elsewhere, traces of argillaceous intraclasts are visible within the poorly sorted sediment. These sandstones are invariably associated with the finer grained sediment types, often occurring at the base of a slate interval. They are interpreted as products of sediment remobilization by local down-slope movements.

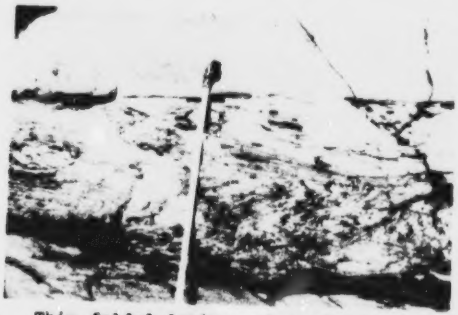


Figure 8. Thin folded laminae of sandstone (lower right) and sandstone pseudonodules (paler) within slate. Gerard Island. Scale tape 70 cm long.

6. **Crosslaminated slate** (Fig. 3). This material consists of crosslaminated silt beds from 0.005 to 0.2 m thick, intercalated with finer slate. Parallel laminated or crosslaminated sand appears rarely at the base of the crosslaminated silt beds. Often the size and frequency of silt bands decreases upwards through a fine grained interval until only starved silt ripples or wisps occur.

7. **Laminated slate.** Fine grained slates occur between sandstones of all types and intercalated between crosslaminated silts. Most slate intervals show occasional parallel laminations or isolated slightly coarser laminae, but some are apparently homogeneous. Internal features are often indistinguishable because of the strong slaty cleavage. These slates are believed to represent "steady-state" deposition under low energy conditions between sand depositing events.

LATERAL CONTINUITY AND VERTICAL SEQUENCES

Figure 3 shows graphic logs of three short, laterally equivalent sections containing most of the above listed sediment types, and illustrating the considerable lateral variability of the sand beds. The following features should be noted: (1) Basal surfaces of major amalgamated sand packages frequently crosscut underlying units, suggesting major channelization of the sandstone packets. (2) Short (5-20 m) sequences may show either thinning- and fining-upward cycles or thickening- and coarsening-upwards cycles. Thinning-upwards cycles are usually equated with channel fills in submarine fan models (e.g. Walker and Mutti, 1973), but are also known to occur in other environments. Further work on the data collected in the 1983 field season will be concentrated on analysis of these vertical and lateral facies relationships in order to arrive at a better understanding of the depositional system.

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GEOLOGY OF THE EASTERNMOST MEGUMA TERRANE OF NOVA SCOTIA, CANADA*

J. D. Keppie

The area is underlain by rocks of the Cambro-Ordovician Meguma Group, divisible into the older Goldenville Formation and the younger Halifax Formation. The Goldenville Formation is made up mainly of turbiditic sandstones grading upward and interbedded with thin slates and siltstones. The Halifax Formation is characterized at low grades by slate interbedded in places with thin sandstones and siltstones. Here, it is generally too poorly exposed to allow subdivision. However, at higher grades, better exposure allowed several distinct units to be recognized: a homogeneous semipelitic schist unit, a coticule (quartz-garnet layers) unit, a graphitic schist unit often ferruginous and with large chiastolite crystals, a banded quartzite/schist unit, and an andalusite schist unit.

Early structures present in the rocks of the Meguma Group range from syndepositional (flutes, ripples, grading, crossbedding, dewatering structures such as sand volcanoes and their pipes and sheet structures, slump structures, etc.) through diagenetic (slide and slump structures, and layer parallel foliation in pelitic units) to tectonic (early monoclines, and grain alignment foliation) structures (Keppie, 1983; O'Brien, 1983).

At some time after consolidation and before the early phase of the Acadian Orogeny, a diversely oriented network of auriferous quartz veins intruded the rocks. Many veins occur preferentially in the slates, generally running parallel to the stratification but locally crosscutting it. Other veins clearly crosscut the bedding and in places merge with the layer-parallel veins (Haynes, 1983; Graves and Zentilli, 1982).

The first major strain recorded by these rocks occurred during the early phase of the Acadian Orogeny (latest Early to Middle Devonian) and produced the major upright to asymmetric, subhorizontal folds associated with the development of pressure solution and slaty cleavage, with the main extension occurring approximately parallel to the fold axes. The small angular differences between several generations of minor folds, pressure solution cleavage-bedding intersection lineations, slaty cleavage-bedding intersection lineations, the long axes of sand volcanoes, and crystal fibres in extension gashes within the quartz veins resulted from a dextral shear component in the deformation (Keppie, 1983). This event is inferred to be a consequence of the accretion of the Meguma Terrane with the Avalon Composite Terrane and dextral movements on the Minas Geofracture (Keppie, 1982). During this event, remobilization of a variety of elements including silica and possibly gold (Clifford et al., 1983; Crocket et al., 1983) led to reprecipitation in veins in tight cylindrical to conical fold hinges (Keppie, 1976).

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*Contribution to Canada-Nova Scotia Co-operative Mineral Program 1981-84. Project carried by Nova Scotia Department of Mines and Energy and by Geological Survey of Canada.

Relaxation of the stresses associated with the latter major event led to gravitational collapse producing a sporadic subhorizontal crenulation cleavage preferentially developed in the pelitic lithologies. In places, this event overlapped into the early part of the succeeding low pressure, Pyrenean static metamorphism characterized by the porphyroblastic, decussate growth of biotite, garnet, staurolite, andalusite, and cordierite. This metamorphism is spatially associated with granitoid plutonism, and although locally a pluton may cut the metamorphic isograds (e.g. Sherbrooke pluton, Smith, 1981), both are believed to be due to the same thermal event dated 365-375 Ma (Dallmeyer and Keppie, 1984). The general absence of gold occurrences above the andalusite-staurolite-cordierite metamorphic isograd in the southwestern Meguma Terrane suggests that the gold was driven out at the higher temperatures.

This thermal event was closely followed by another major Late Acadian deformational event (Dallmeyer and Keppie, 1984). This produced ductile deformation zones that are best developed adjacent to the Minas Geofracture. The effects of this deformation are dependent upon the lithology and the intensity of strain. In granite, a flattening foliation at the lower strains is accompanied by spaced shear planes at higher strains (C-S fabric). In the Halifax Formation: (i) at relatively lower strains, the early Acadian slaty cleavage and bedding are transposed into parallelism accompanied by rotation of bedding and slaty cleavage relative to porphyroblastic crystals, rotation of ac veins towards the plane of the bedding and cleavage, and the development of steeply plunging northeast-southwest folds, and (ii) at relatively higher strains, a mylonitic fabric develops with a subhorizontal mineral stretching lineation, in places associated with a crenulation cleavage; porphyroblasts are rotated into a subhorizontal extension direction and sheath folds form.

In the Goldenville Formation, strain is concentrated in the pelitic layers, which develop structures similar to those of the Halifax Formation. The interbedded sandstones are relatively mildly deformed except at extreme strains. Kinematic analysis of these ductile deformation zones suggests they were formed by the dextral shear movements associated with the Minas Geofracture during greenschist facies metamorphic conditions. Pre-existing auriferous quartz veins are folded and/or boudinaged, as they are deformed in the ductile deformation zones. Silica and gold are remobilized (Smith, 1983) in these ductile deformation zones and there appears to be some genetic relationship between these zones and the locations of gold deposits at Cochrane Hill, Mile Lake, Country Harbour, and Forest Hill, which all lie in the same ductile deformation zone.

Finally, the area was cut by a series of northwest-southeast sinistral brittle ductile transcurrent faults, the largest being the Country Harbour Fault. This Fault has displaced the Minas Geofracture into two segments: the Guysborough County Fault and the West River St. Marys Fault. It folded the Guysborough County Fault and the adjacent ductile deformation zone between Salmon River and Country Harbour. These faults are spatially associated with sinistral northwest-southeast kink bands sometimes containing devitrified pseudotachylite breccia. Conjugate dextral northeast-southwest kink bands are present only rarely. The faults and kink bands are inferred to be contemporaneous with sinistral displacements observed on east-west shear planes. This movement is postulated to have taken place in the early Mesozoic, during formation of the Bay of Fundy Rift.

Later structures include rare conjugate, gently dipping kink bands. These are cut by both dextral and sinistral north-south subvertical fracture zones.

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TECTONOTHERMAL EVOLUTION OF THE MEGUMA TERRANE: RADIOMETRIC CONTROLS[*]

J. D. Keppie, L. Odom[**] and R. F. Cormier[***]

ABSTRACT

The Meguma Terrane consists largely of Paleozoic rocks underlain by generally unexposed continental crust with calculated seismic compressional velocities of 5.4 and 6.5 km/sec. The Cambro-Ordovician Meguma Group is unconformably to disconformably overlain by Silurian-Early Devonian rocks. This Taconic hiatus may be accompanied by local deformation in the Yarmouth area. These Lower Paleozoic rocks were deformed during the Acadian Orogeny followed by a low pressure static metamorphism. This was followed by granitoid plutonism. Some of the plutons are cut by foliations and shear zones.

Radiometric controls on the timing of these events are as follows: (1) U/Pb upper intercept age of 1180 Ma[*] on clear, magmatic, zircon crystals from a thrust slice of orthogneisses gives the intrusive age of a pluton in the continental basement; (2) a 450 ± 5 Ma Rb/Sr whole rock isochron (Ro=0.709 ± 0.002) on the same body may be ascribed to the Taconian event; (3) $^{40}Ar/^{39}Ar$ total gas ages of 400-415 Ma on slate record the age of the Acadian deformation; (4) Rb/Sr whole rock isochron on the South Mountain batholith range from 372 ± 2 Ma to 361 ± 1 Ma, while a Rb/Sr whole rock isochron on the Wedgeport pluton yielded a 316 ± 17 Ma age (Ro=0.715 ± 0.007), which is consistent with concordant zircon ages of 313 ± 3 Ma; (5) a $^{40}Ar/^{39}Ar$ plateau age of 258 ± 8 Ma on biotites from the Wedgeport pluton and comparable Rb/Sr mineral isochrons are ascribed to the effects of Hercynian deformation.

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[*] Geological Society of America, Abstracts with Programs, 1983, v. 15, p. 136.

[**] Department of Geology, Florida State University, Tallahasse, Florida.

[***] Department of Geology, St. Francis Xavier University, Antigonish, Nova Scotia.

[*] **AUTHOR'S NOTE** Since this abstract was published it appears possible that these samples were mixed up with others at the laboratory at Florida State University. This result formed the basis for assigning the unit to the basement on the Tectonic Map of Nova Scotia by J.D. Keppie, 1982, Nova Scotia Department of Mines and Energy. As a result of the doubt cast on the validity of the data, the age and the subsequent conclusions should be treated with extreme caution. The unit has been resampled for repeat isotopic analysis.--J.D. Keppie.

FOLD AND CLEAVAGE DEVELOPMENT IN AN APPALACHIAN SLATE BELT*

B. H. O'Brien

Greenschist facies sedimentary rocks of the slate belt association occur in the Meguma Group of southeastern Nova Scotia. They illustrate a long history of inhomogeneous progressive deformation. Several variably pervasive but regionally recognizable increments of deformation produced folds, cleavages and lineations superimposed, for the most part, coaxially.

The earliest increment gave rise to a layer-parallel shear throughout a 5-10 km thick shale-sandstone multilayer. Flattening associated with layer-parallel shear is evidenced by the formation of gently dipping, variably penetrative, grain alignment cleavage and the rare development of gently plunging, step folds. The step folds are observable on the minor and mesoscopic scales in restricted areas and are interpreted to have formed regionally. They may be drape or forced folds. Alternatively, such folds might mark zones where compressive stresses related to the most intense layer-parallel shear occurred and caused detachment of the multilayer from its inferred basement.

Layer-parallel shearing was followed by a period of layer-parallel shortening. Where the multilayer remained flat, gently plunging parallel folds were produced by buckling. Depending upon the ratio of competent to incompetent beds, the buckle folds developed by either flexural slip folding or neutral surface folding. During an early stage in the buckling of the multilayer and after the imposition of grain alignment cleavage, pressure solution cleavage began to develop with a characteristic moderate dip near the hinge and on the limbs. This notably spaced cleavage, together with certain quartz veins and the earlier, more penetrative intralithon cleavage, was passively folded and steepened. In having done so, they provide a record of most of the limb rotation during buckling. Newer and successively steeper pressure solution seams were initiated as the fold limbs continued to rotate externally about the fold axes and the axial surfaces approached the vertical. Subsequent to most but not all of the buckle folding and late in the episode of layer-parallel shortening the generally upright slaty cleavage was imposed on all earlier folds. Slaty cleavage-related flattening locally produced minor folds, in particular cuspate isoclines of the bedding. Objects in the plane of the steep foliation are typically extended subhorizontally parallel to the regional fold axes. Rotation of obliquely oriented step folds into the regional east-west grain of the slate belt occurred before or during the formation of the slaty cleavage. Regional wrench movements may have been active early during buckling as well as late during the imposition of the vertical pressure solution and slaty cleavages.

A partially analagous sequence of incremental strains has been recorded for the Martinsburg Slate in New Jersey. However, noteworthy features of this Appalachian slate belt are: (1) the timing of the development of spaced, pressure solution cleavage relative to the other morphological varieties of cleavage, (2) the dissolution of grains during volume-change deformation affecting pre-existing greenschist facies as well as detrital minerals, and (3) the steepening of restricted parts of the multilayer to the near vertical before the development of the cleavages and folds typical of the slate belt association.

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*The Canadian Tectonics Group Annual Meeting and Workshop, October 1983, Jasper, Alberta.

SLATE BELT TECTONICS IN THE BICKERTON BARRENS, N.S.: HORIZONTAL EXTENSION AND SIMPLE SHEAR WITHIN THE MEGUMA BASIN*

E. H. O'Brien

Greenschist facies sedimentary rocks underlying the Bickerton Barrens illustrate a long history of inhomogeneous progressive deformation. A discontinuous deformation path gave rise to several phases of deformation, each governed by a particular type of crustal shortening. The earliest event produced a layer-parallel shear of variable intensity throughout a shale-sandstone multilayer exceeding 5 km in thickness. Within the multilayer, the bedding and stratiform quartz veins acted as both the principal planes of shear and anisotropy. Flattening associated with layer-parallel shear is evidenced by the formation of gently dipping, grain alignment cleavage, and the development of gently plunging step folds. Localities where bedding is downfolded may mark the site of underlying faults, perhaps themselves rooted in the basement to the multilayer. The Meguma slate belt is held to be thin-skinned.

Layer-parallel shearing was followed by a period of layer-parallel shortening. Where the multilayer remained flat, gently plunging parallel folds were produced by buckling. Depending upon the ratio of competent to incompetent beds, the buckle folds developed by either flexural slip folding or neutral surface folding. At an early stage in the buckling of the multilayer, pressure solution cleavage began to develop with a characteristic moderate dip. This cleavage, together with certain quartz veins and the grain alignment cleavage, was passively folded and steepened. In having done so, they provide a record of most of the limb rotation during buckling. Newer and successively steeper pressure solution stripes were initiated as the fold limbs continued to rotate, and the axial surfaces approached the vertical. Subsequent to most but not all of the buckle folding, and late in the episode of layer-parallel shortening, the generally upright slaty cleavage was imposed on all earlier folds. Cleavage-related flattening locally produced minor folds, in particular cuspate isoclines of the bedding. Objects in the plane of the steep foliation are typically extended subhorizontally parallel to the regional fold axes. Rotation of obliquely oriented step folds into the regional east-west grain of the slate belt occurred before or during the formation of the slaty cleavage. Regional wrench movements may have been active early during buckling as well late during the imposition of the upright LS-fabrics.

After the beds acquired slaty cleavage, they ceased to behave as a multilayer. Gravitational instability following inhomogeneous layer-parallel shortening probably caused the vertical collapse of the slate belt. An associated flattening produced variably intense, but regionally pervasive subrecumbent folds and gently dipping crenulation cleavage. Superimposed coaxially on the major fold structures, they are commonly seen to affect the steep cleavages but rarely to deform the bedding. There does not appear to be any preferred direction of translation during this episode of shortening.

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*The Atlantic Geoscience Society Symposium, Program with Abstracts, January 1983, Fredericton, New Brunswick.

The slate belt largely acquired its present configuration in a period of shear folding that most likely succeeded gravitational collapse. At this time the strong, upright foliations were the principal planes of anisotropy and so became the principal planes of shear. The hinges of the major folds suffered relatively large strains late in the layer-parallel shortening event and, therefore, they were naturally favoured to be the most active sites of shear folding. Reclined crossfolds and crenulations possibly resulted from shear-related compression; their conjugate nature reflecting both dextral and sinistral movements. En echelon boudins extended equally in several directions seem to imply a plane strain and an operative simple shear.

GEOLOGY AND LITHOGEOCHEMISTRY OF THE COCHRANE HILL GOLD DEPOSIT - AN INDICATION OF METALLIFEROUS SOURCE BEDS*

P. K. Smith

INTRODUCTION

The Cochrane Hill open-pit gold deposit lies on the southern overturned limb of the Cochrane Hill Anticline (Fig. 1) approximately 200 m south of the fold axial trace. The host Meguma Group strata were deposited under turbidite-like conditions, polydeformed into east-west trending folds, metamorphosed to the amphibolite facies and subsequently intruded by granitic plutonism. Gold and associated lead-zinc mineralization at Cochrane Hill occurs in composite quartz bearing veins typified by their diverse silicate and ore mineralogy. These veins represent six distinct types (designated A-F, Smith, 1983a, b) based on relative age and mineralogy. Visible gold found in both veins and adjacent wall rock represents not less than two distinct episodes of mineralization relative to regional metamorphism. Multielement lithogeochemistry suggests that specific, identifiable pelitic units may represent, at least in part, the original source beds for the mineralization. The recognition of these distinct groups of metapelites within the Meguma Group could have profound exploration significance leading to the discovery of new mineralization in southern Nova Scotia.

STRATIGRAPHY

Cochrane Hill lies approximately 1.3 km structurally below the Halifax-Goldenville boundary. The isoclinal nature of the fold, associated parasitic folds, subsequent postfold deformation and significant gaps in exposure make a true estimate of stratigraphic thickness below the Halifax Formation difficult. The mineralized host rocks are predominantly metapsammite and metapelite. The cyclic distribution of these rock types across the pit area is represented in a schematic sectional plan view (Fig. 2). There are significant textural, mineralogical and geochemical variations in the metapelite lithology. The predominant metapelite is characterized by a high content of staurolite porphyroblasts, numerous thin interbeds of calc-silicates and the obvious absence of quartz veins.

The second less prominent metapelite unit is the most interesting and important in terms of mineralization. It is characterized by abundant sulphides (mostly arsenopyrite), abundant quartz veins, general lack of calc-silicates and an abundance of visible gold, both in the vein material and in the host metapelite. These two metapelite lithologies are referred to as staurolite/calc-silicate and metalliferous metapelites respectively.

The metapsammite lithologies are divided into two distinct mapable units (Fig. 2) that differ mainly in colour and alteration. The siliceous metapsammite in the open-pit appears to be the altered equivalent

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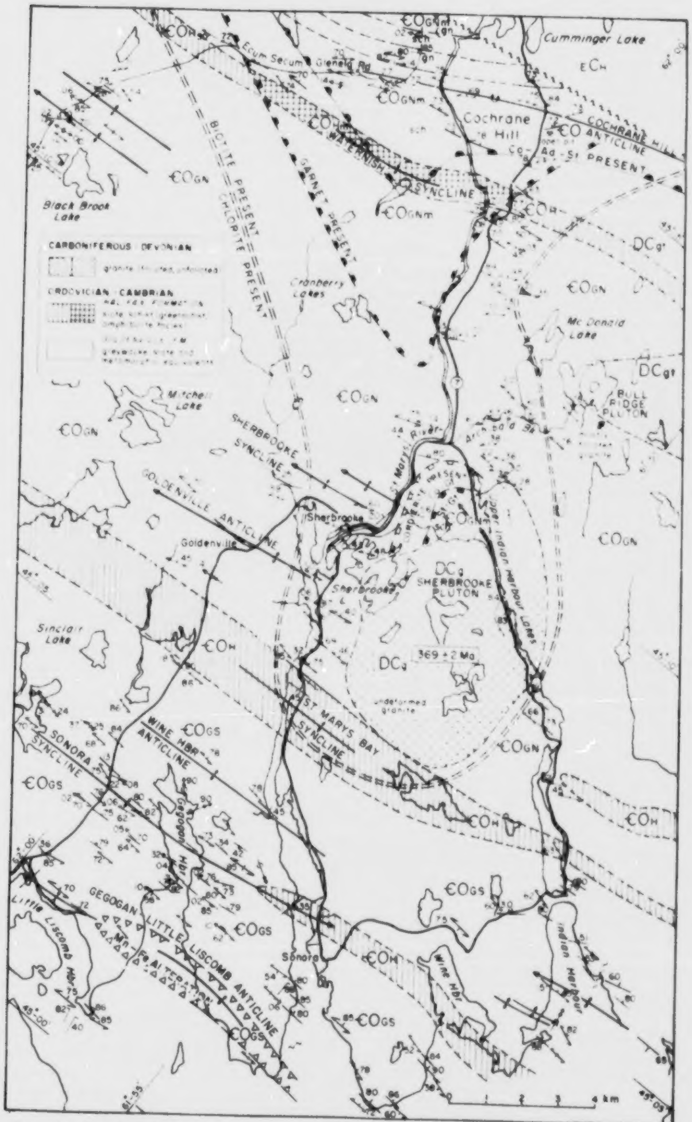
*Contribution to Canada-Nova Scotia Co-operative Mineral Program 1981-84. Project carried by Nova Scotia Department of Mines and Energy and Geological Survey of Canada.


Cumminger Lake
€CH
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Cochrane Hill
€O
COCHRANE HILL ANTICLINE
Ad - St PRESENT
€OH
WATERNISH SYNCLINE
€OGN
Black Brook Lake
BIOTITE PRESENT
CHLORITE PRESENT
GARNET PRESENT
CARBONIFEROUS - DEVONIAN
ORDOVICIAN - CAMBRIAN
Cranberry Lakes
DCgf
Mc Donald Lake
BULL RIDGE PLUTON
Mitchell Lake
SHERBROOKE SYNCLINE
GOLDENVILLE ANTICLINE
St Marys River
Goldenville
Sherbrooke
Sherbrooke L
Upper Indian Harbour Lakes
DCg
SHERBROOKE PLUTON
369 ± 2 Ma
undeformed granite
Sinclair Lake
€OGS
SONORA SYNCLINE
WINE HBR ANTICLINE
ST MARYS BAY SYNCLINE
Gegogan Hbr
GEGOGAN
LITTLE LISCOMB ANTICLINE
Mn-Fe ALTERATION
Little Liscomb Hbr
Sonora
Wine Hbr
Indian Harbour
0 1 2 3 4 km
45°00'
61°55'
62°00'

Figure 1. General geological map showing location of the Cochrane Hill gold deposit and the approximate boundary between the northern and southern domains (modified after Smith, 1981).

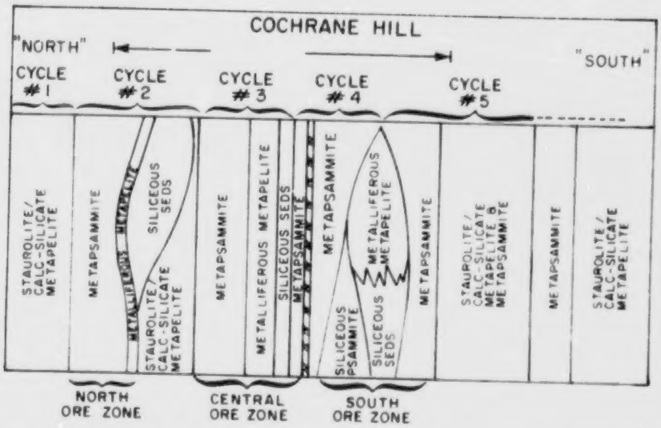
COCHRANE HILL
"NORTH"
"SOUTH"
CYCLE #1
CYCLE #2
CYCLE #3
CYCLE #4
CYCLE #5
STAUROLITE/ CALC-SILICATE METAPELITE
METAPSAMMITE
METALLIFEROUS METAPELITE
SILICEOUS SEDS
STAUROLITE/ CALC-SILICATE METAPELITE
METAPSAMMITE
METALLIFEROUS METAPELITE
SILICEOUS SEDS
METAPSAMMITE
METAPSAMMITE
METALLIFEROUS METAPELITE
SILICEOUS PSAMMITE
SILICEOUS SEDS
METAPSAMMITE
STAUROLITE/ CALC-SILICATE METAPELITE & METAPSAMMITE
METAPSAMMITE
STAUROLITE/ CALC-SILICATE METAPELITE
NORTH ORE ZONE
CENTRAL ORE ZONE
SOUTH ORE ZONE

Figure 2. Schematic sectional plan diagram depicting apparent cyclic nature of lithological units across the Cochrane Hill mine area. Locally within individual units (especially schist) tight isoclinal minor folding with subhorizontal fold axis, deforms both veins and bedding. Beds young towards the south and dip towards the north.

of the more typical metapsammite (see below). The silicified strata are light green in colour and have numerous very thin crosscutting stringers filled with chlorite ± quartz and have extensive bleach zones along their margins. Calc-silicate lenses and tightly folded stratabound quartz veins are common. These altered strata grade into unaltered metapsammite along strike. The unaltered metapsammite strata are medium fine grained, blue-grey in colour with beds less than 1 m thick. Quartz veins are common within these strata, but they lack the thin crosscutting stringers with their associated bleach zones.

STRUCTURE

The Cochrane Hill mine lies in the complexly deformed northern domain (Smith, 1983a) of the Meguma Group approximately 1 km south of the West River St. Marys Fault (Benson, 1974) which separates Lower Paleozoic strata to the south from Carboniferous strata to the north. The Cochrane Hill Anticline, which can be traced for at least 40 km west and east of the mine site, plunges gently to steeply westward. Cleavage development before, during, and after the major upright folds, is well documented in the greenschist facies south of Cochrane Hill (O'Brien, 1983). Around Cochrane Hill several later penetrative foliations are superimposed on the regional static metamorphism and all earlier cleavages, as well as on some granitic plutons (Smith, 1983a; Chevalier, 1983). Several later generations of crenulation cleavages, shear cleavages and kink bands deform the overprint foliations. The age of all the major cleavages (both pre- and postplutonism) as well as regional metamorphism and granitic plutonism give an apparent Devonian age (Dallmeyer and Keppie, 1984).

METAMORPHISM

Amphibolite grade regional metamorphism prevails throughout the northern domain with porphyroblastic minerals including biotite, muscovite, garnet, cordierite, staurolite and andalusite. These porphyroblasts overgrow earlier foliations and are subsequently deformed by the later overprint foliations (Smith, 1983a and b; Keppie, 1983). The relative age of this regional metamorphism across the Meguma Zone is established from the recognition of similar fabric elements in both the southern and northern domains (Smith, 1983a). The absolute age of porphyroblastic biotite and the biotite in all other cleavages gives an apparent consistent age of approximately 370 Ma (Dallmeyer and Keppie, 1984). It therefore follows that the regional static metamorphism, all cleavage development and granitoid plutonism occurred at the same time ≈ 370 Ma. This has profound implications on any genetic model used to explain the mineralization because auriferous quartz veins both pre- and postdate the regional porphyroblasts. However, this author concludes that around Cochrane Hill there is substantially higher regional metamorphism resulting from thermal doming above an unknown heat source. This could occur above a granitoid pluton (observed pegmatites) or in an area of abnormally high heat flow.

VEINS

Auriferous quartz veins of the Cochrane Hill gold deposit have been subdivided into six types (Fig. 3) based on differences in texture, mineralogy and relative age (Smith, 1983a). The earliest veins which are micro-crosslaminated show low angle crosscutting relationships with bedding dictating that they formed after Cambro-Ordovician sedimentation, but before the onset of deformation (Acadian Orogeny) during the Devonian. These early veins commonly display a composite texture resulting from later quartz emplacement along them. The end result is a texture locally referred to as "speckled-hen" (Fig. 4). Spectacular examples of this texture exist in many gold deposits in Nova Scotia, especially the Caribou gold mine, where the later quartz vein crosscuts bedding at a high angle after following along a laminated vein for some distance. At Cochrane Hill it can be demonstrated in a single vein that the early laminated portion of the vein is overgrown by garnet porphyroblasts and the later massive portion of the composite vein crosscuts these garnets.

Stratabound type B veins have marked variations in both ore and silicate mineralogy (Smith, 1983a and b) and are the most abundant at Cochrane Hill. They frequently crosscut biotite, garnet and staurolite porphyroblasts which preferentially concentrate adjacent to these veins. High concentrations of plagioclase, biotite, actinolite and garnet with the accessory minerals apatite, sphene and rutile are common as well as sulphide minerals. Type C bedding parallel veins are similar to type B veins except they are smaller, less abundant and are composite in nature. Crosscutting type D veins are uncommon at Cochrane Hill and are more prominent outside the mine. Type E pegmatoid veins are characterized by the presence of andalusite, muscovite, biotite and plagioclase as well as sphene, apatite and rutile. Tourmaline alteration of the wall rock around these veins is common. This is also observed with granite pegmatites

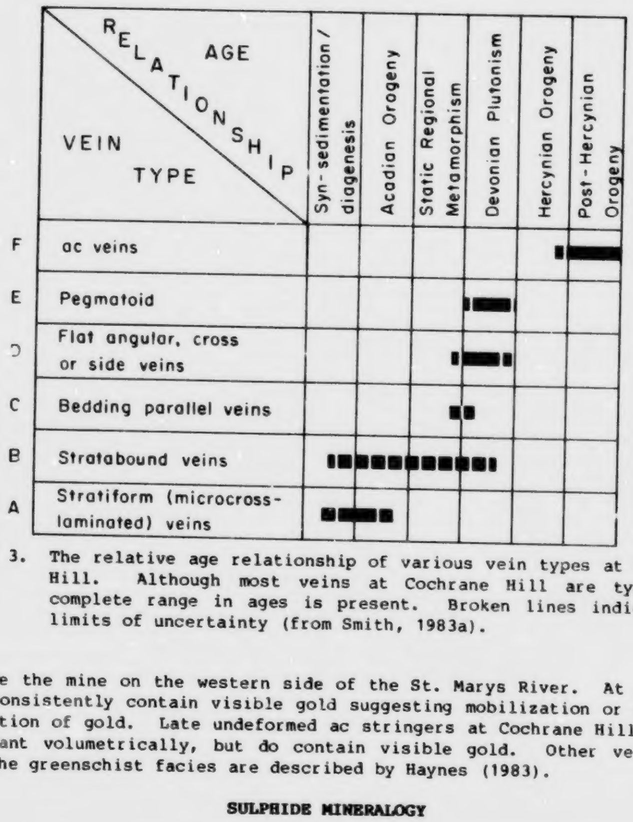

Figure 3. The relative age relationship of various vein types at Cochrane Hill. Although most veins at Cochrane Hill are type B, a complete range in ages is present. Broken lines indicate the limits of uncertainty (from Smith, 1983a).

outside the mine on the western side of the St. Marys River. At the mine they consistently contain visible gold suggesting mobilization or a second generation of gold. Late undeformed ac stringers at Cochrane Hill are not important volumetrically, but do contain visible gold. Other vein types from the greenschist facies are described by Haynes (1983).

SULPHIDE MINERALOGY

Throughout the Cochrane Hill mine area arsenopyrite is the most abundant sulphide mineral representing in excess of 10 per cent of some rock samples. For this reason a brief description of arsenopyrite is given with a more detailed account to follow in a subsequent publication.

ARSENOPYRITE

Arsenopyrite occurs as alteration zones along many veins as well as being disseminated through the host rocks. Textural observations show several populations of arsenopyrite crystals, of which some, if not all populations, have associated visible gold. A study by Graves (1976) of arsenopyrite from various greenschist facies gold deposits discussed the significance of the composition of the arsenopyrite as a geothermometer. A plot of As against S of his data clearly shows a bimodal distribution

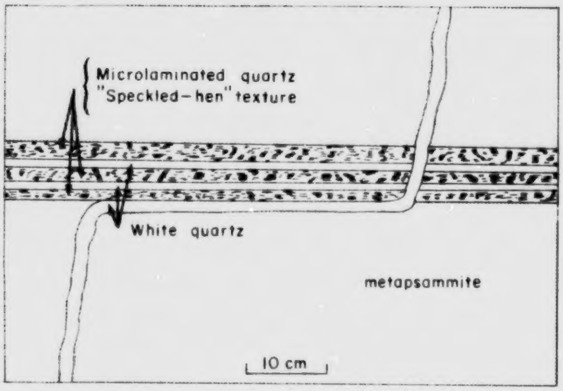

Figure 4a. Composite quartz vein. The major part of the vein possessing the "speckled-hen" texture lies parallel to bedding. Alternating layers of microlaminated quartz separated by layers of white crystalline quartz are common. Locally the white quartz cuts bedding at a high angle and then lies parallel to the vein wall thus increasing the overall thickness of the vein at that point each time new white quartz is added.

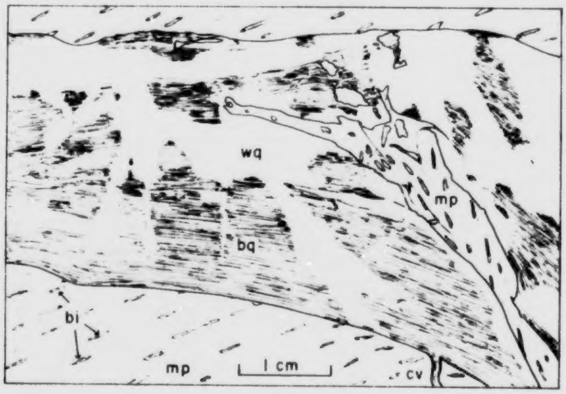

Figure 4b. "Speckled-hen" texture in microlaminated quartz vein hosted by dark graphitic metapelite (mp). The texture is defined by black quartz (bq) which forms columnar-like structures that are surrounded by dense white quartz (wq). Individual bands or microlaminae which form the columnar-like structures consist of thin layers of wall rock. The white quartz appears to locally destroy or disrupt the alignment of the individual laminae. The biotite porphyroblasts (bi) which are parallel to the foliation are crosscut by the dark laminae. Note how the laminae swing into a small cross vein (cv) at the bottom of the figure.

(Fig. 5). Microprobe analyses of arsenopyrite from Cochrane Hill (Fig. 6) show a much wider range in composition than that observed from the greenschist facies (Graves, 1976) with up to 40 atomic weight per cent As in some crystals. Many of the arsenopyrite crystals at Cochrane Hill show exsolution textures of pyrrhotite, sphalerite ± galena ± chalcopyrite ± loellingite. Sphalerite is often observed rimming the arsenopyrite. Visible gold occurs within and around all textural types of arsenopyrite as well as with pyrrhotite, sphalerite, galena and some phyllosilicates.

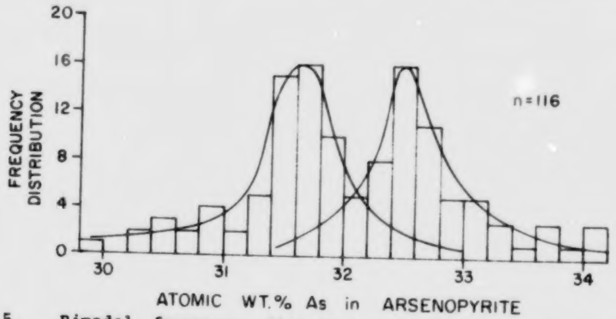

Figure 5. Bimodal frequency distribution histogram of atomic weight per cent arsenic (As) in arsenopyrite crystals from greenschist facies throughout the Meguma Zone. Data from Graves (1974).

LITHOGEOCHEMISTRY

Detailed lithogeochemistry was conducted on samples across four well exposed sections of the open-pit at Cochrane Hill. A plot of Au, Cu + Pb + Zn, normalized K/Na ratio and normalized Fe/Mn ratio across the south wall section (Fig. 7) shows a strong correlation between these elements and ratios. Ratios are normalized against world averages for shales and sandstones. Gold values are particularly elevated in the quartz veins with the exception of one vein that also shows low Cu + Pb + Zn, normalized K/Na and normalized Fe/Mn (Fig. 7). These normalized ratios for veins and some pelites suggest a strong relative enrichment of K and Fe. Alkali feldspar is not present in any of the veins, but plagioclase of variable composition (probe data) is common in most. Where potassium content is high the potassium is incorporated in the mica phase. Where sodium content is high the element shows up as high albite content in the plagioclase. The normalized Fe/Mn content appears mainly controlled by the garnet, mica and/or amphibole (tremolite) contents.

Across this section (Fig. 7) it is obvious that there are significant differences in the metal content and element ratios. Field observations indicate that the metapelitic units throughout the open-pit area can be subdivided into at least two groups based on their mineralogy: a staurolite/calc-silicate group, and a metal-rich group. Several random samples were chosen from each metapelite group and the geochemistry from the two groups compared (Table 1). It becomes apparent that there is relative enrichment of Ag, As, Au, B, Ca, Cd, Co, Mo, Pb, S, Sb, Sr, and

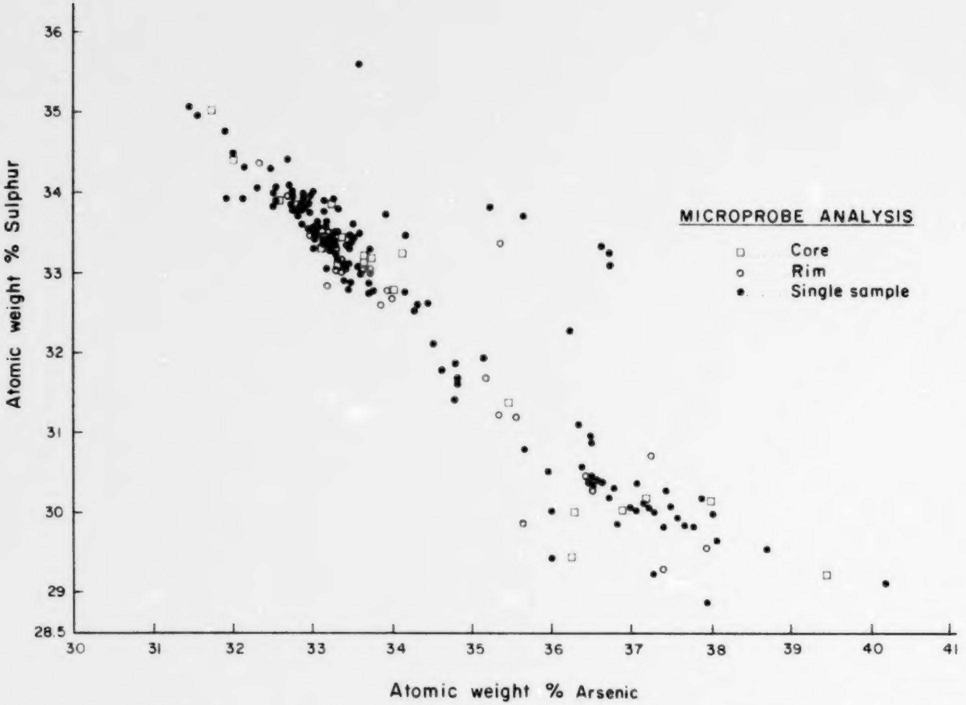

Figure 6. Microprobe analysis of atomic weight per cent arsenic (As) against atomic weight per cent sulphur (S) in arsenopyrite crystals from Cochrane Hill.

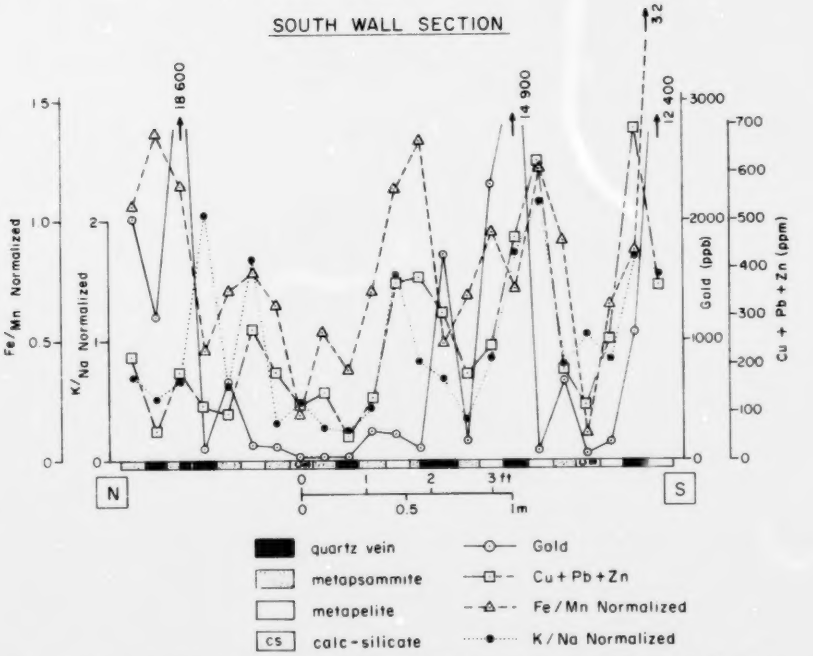

Figure 7. Geochemical variation of normalized K/Na, normalized Fe/Mn, Au, and Cu + Pb + Zn across a portion of the south wall section at Cochrane Hill. Values are normalized against world shales and sandstones.

Zn. The significance of this multielement enrichment suggests that this metalliferous metapelitic zone might represent the source beds for the gold mineralization. Remobilization of the metals towards the margins of quartz veins occurred after the emplacement of the veins during metamorphism, plutonism and subsequent deformation.

Mineralogically the metalliferous metapelite group at Cochrane Hill contains abundant sulphides (arsenopyrite, pyrrhotite, pyrite, galena, sphalerite ± chalcopyrite), garnet and biotite prophyroblasts, minor andalusite, cordierite and staurolite porphyroblasts, no calc-silicates and numerous quartz veins. However, the other metapelite group has a high content of staurolite and biotite, minor garnet, numerous calc-silicates and the obvious lack of quartz veins and arsenopyrite.

It is suggested that these mineralogically distinct rock types represent totally different chemical environments, possibly reflecting different source areas that contributed material to these strata. This is based on the fact that the metalliferous metapelite units appear to interfinger with the more typical Goldenville stratigraphy.

Table 1. The major and trace element variations (average) of the lithologically distinct metapelitic horizons in the Cochrane Hill open-pit mine. Number of samples is indicated by "n". Shading indicates elements showing significant enrichment relative to the staurolite/calc-silicate metapelites.

n=3 STAUROLITE/CALC-SILICATE METAPELITE			n=6 METALLIFEROUS METAPELITE		
Majors (Wt%)	Traces (ppm)		Majors (Wt %)	Traces (ppm)	
SiO_2 52.19	Ag 0.02	La 30	SiO_2 56.17	Ag 0.09	La 33
Ti 0.594	As 242	Li 43	Ti 0.549	As 14 733	Li 57
Al 9.25	Au 0.288	Mo 1.0	Al 9.16	Au 1 574	Mo 2.6
Fe 5.46	B 40	Ni 33	Fe 5.35	B 107	Ni 38
Mn 0.070	Ba 767	Pb 35	Mn 0.078	Ba 581	Pb 266
Mg 1.95	Be 2.3	Rb 187	Mg 1.71	Be 2.8	Rb 171
Ca 0.41	Cd 1.7	Sb 2.0	Ca 0.825	Cd 3.0	Sb 14
K 4.08	Co 26	Sn 1.0	K 3.53	Co 39	Sn 1.0
Na 1.18	Cr 96	Sr 83	Na 1.60	Cr 89	Sr 125
H_2O^+ 0.79	Cs 6.0	Th 0.7	H_2O^+ 0.74	Cs 7.0	Th 0.7
CO_2 0.34	Cu 32	V 133	CO_2 0.41	Cu 23	V 121
S 0.24	F 373	W 1.0	S 1.05	F 363	W 1.0
P 0.0585	Hg 10	Zn 138	P 0.0579	Hg 10	Zn 558
		Zr 170			Zr 196

CONCLUSION

From the examination of the amphibolite grade, turbidite hosted gold deposit at Cochrane Hill several conclusions in brief are drawn.

1. There is cyclic stratigraphy across the open-pit. However, tight isoclinal folding has repeated some units on a local scale.

2. The area has been polydeformed. Several generations of cleavage and associated folds both pre- and postdate the regional static metamorphism.

3. Textural evidence for the porphyroblastic minerals indicate that peak metamorphic conditions may have been achieved more than once or persisted for an extended period of time in this area. However, $^{40}Ar/^{39}Ar$ dates suggest that all biotites formed at about 370 Ma.

4. Quartz veins represent several distinct types with differing ages, mineralogy, and textures. Gold and arsenopyrite in these veins are of several generations. The arsenopyrite shows high variation in element concentration.

5. Gold values are strongly influenced by the proximity of the quartz veins.

6. Normalized K/Na and Fe/Mn ratios show a strong correlation to each other and to Cu + Pb + Zn. The high variation in normalized values probably reflects the extreme mobility of the elements.

7. Lithology and geochemistry clearly distinguish two distinct groups of pelite, with one group showing a strong enrichment of Ag, As, Au, B, Ca, Cd, Co, Mo, Pb, S, Sb, Sr, and Zn. These metalliferous metapelites at Cochrane Hill may represent the original source beds of the mineralization. Similar situations may prevail in other gold districts throughout Nova Scotia.

Clearly, any genetic model proposed to explain the gold mineralization must address all of the observations. In doing so it becomes apparent that the time frame involved starts with sedimentation (questionable source beds) and may not end until the last phases of tectonism in the area end. Thus it would appear that diagenesis, deformation, metamorphism, plutonism and their respective effects have all played a critical role in the polygenetic history of the Cochrane Hill gold deposit.

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POLYGENESIS OF GOLD DEPOSITS, EASTERN MEGUMA DOMAIN*

S. J. Haynes

The gold deposits of the eastern Meguma Terrane are hosted by turbidite sequences of the Goldenville Formation. Regional metamorphism ranges from chlorite grade in the south to staurolite-andalusite grade in the north (Fig. 1).

In the greenschist facies, eleven different quartz vein polytypes are present (Haynes, 1983). Here, gold is present in both host rock metalliferous slates and early vein types predating granitoid intrusion and Acadian deformations and metamorphism (Fig. 2). The presence of mesoscopic monoclines and monoclinal flexures (Keppie, 1983; O'Brien, 1983) on the flanks of Acadian folds in several gold districts suggests these flexures may be related to early fault zones (Haynes, 1983). Solution channelways along such faults may be represented by crosscutting step quartz veins, containing coarse K-feldspar, that assumed their present shape during Acadian flexural-slip folding. Both step veins and stratabound veins exhibit marked arsenopyritization, sericitization and silicification of the wall rocks. These stratiform veins were the main past producers of gold. They exhibit crosslamination and columnar structures, and are usually rich in carbonate. Stratabound veins are often auriferous and may form economically viable ores (e.g. main orebody, Caribou Mines, Halifax County). The other vein polytypes (Haynes, 1983) were successively emplaced during or after the main period of gold mineralization and Acadian folding. These polytypes generally display low gold values, so it is unlikely that gold was significantly mobilized during Acadian fold dilation.

Chemical analyses of an auriferous stratiform vein and wall rocks at the Mulgrave shaft, Goldboro, reveal a direct logarithmic relationship of Au, Ag, Hg, and, to a lesser degree, Sb (Fig. 3). In the quartz vein these elements are also directly related to As and S (Fig. 4) due to the association of arsenopyrite with native gold. In the host rocks the distribution of As and S is not directly related to Au, because native gold is present as fine blebs and wisps scattered throughout the sediment matrix independent of the distribution of arsenopyrite and other sulphides.

Arsenopyrite, gold, and sphalerite from quartz veins in the greenschist facies were analyzed by electron microprobe. Arsenopyrites are commonly zoned with most values between 32 and 34 atomic per cent As, and all values between 30 and 35.5 atomic per cent As. Although pyrite was observed in the same polished sections as arsenopyrite-pyrrhotite pairs, no three-phase mutual grain boundaries were observed, hence Kretschmar and Scott's (1976) arsenopyrite geothermometer cannot be used without determination of sulphur fugacity (Fig. 5). Application of the electrum tarnish curves of Barton and Toulmin (1964) to the gold analyses reveals that the

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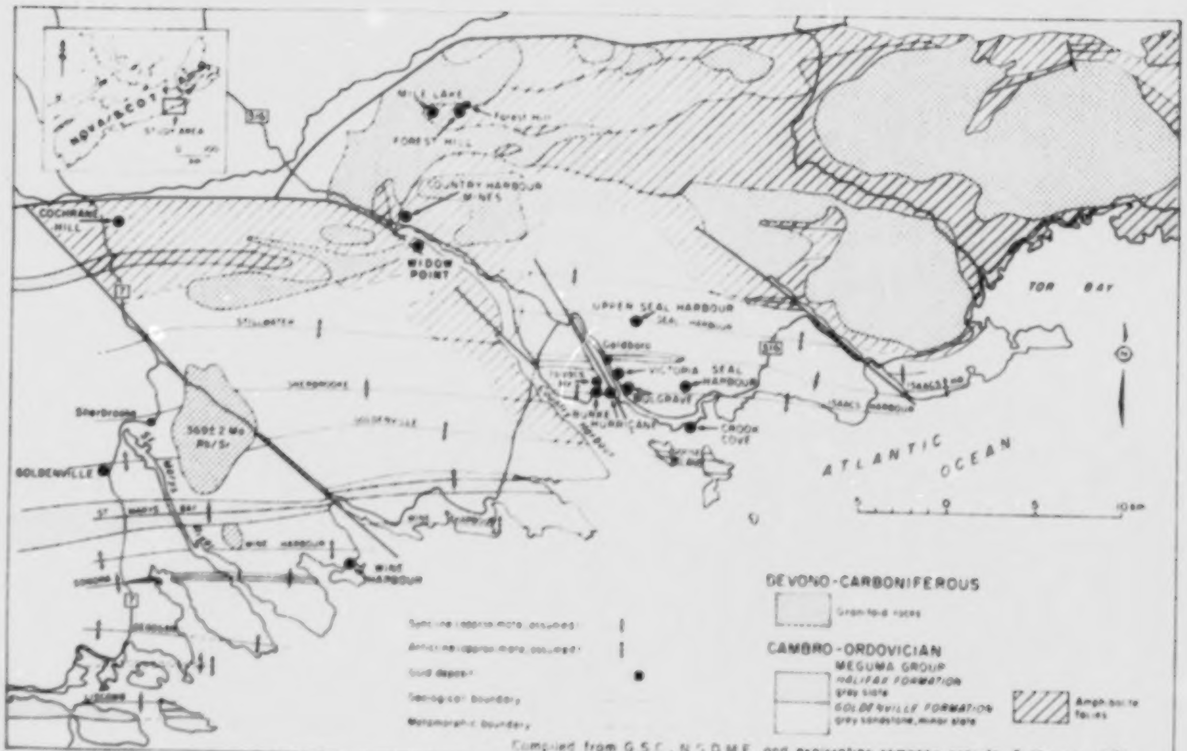
*Contribution to Canada-Nova Scotia Co-operative Mineral Program 1981-84. Project carried by Nova Scotia Department of Mines and Energy and Geological Survey of Canada.


NOVA SCOTIA
STUDY AREA
MILL LAKE
Forest Hill
FOREST HILL
COUNTRY HARBOUR MINES
COCHRANE HILL
WIDOW POINT
UPPER SEAL HARBOUR
SEAL HARBOUR
Goldboro
VICTORIA
SEAL HARBOUR
BOLGRAVE
BURKE
HURRICANE
CROOK COVE
Sherbrooke
GOLDENVILLE
360±2 Ma Rb/Sr
WINE HARBOUR
TOR BAY
ATLANTIC OCEAN
ISAACS HARBOUR
7
316
0
5
10 km
DEVONO-CARBONIFEROUS
Granitoid rocks
CAMBRO-ORDOVICIAN
MEGUMA GROUP
HALIFAX FORMATION
gray slate
GOLDENVILLE FORMATION
gray sandstone, minor slate
Amphibolite facies
Syncline (approximate, assumed)
Anticline (approximate, assumed)
Gold deposit
Geological boundary
Metamorphic boundary

Compiled from G.S.C., N.S.D.M.E. and exploration company reports S. Haynes, 1983

Figure 1. Location of gold deposits and geology of the eastern Meguma Terrane.

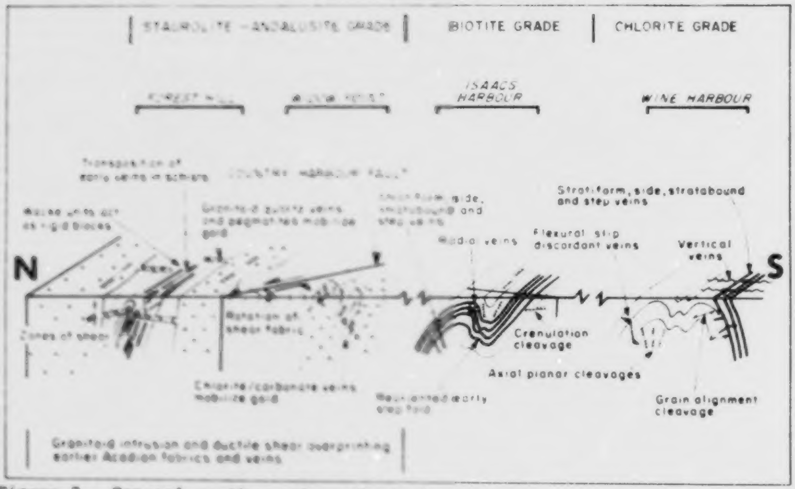

STAUROLITE – ANDALUSITE GRADE
BIOTITE GRADE
CHLORITE GRADE
FOREST HILL
ISAACS HARBOUR
WINE HARBOUR
Transposition of early veins in schists
COUNTRY HARBOUR FAULT
Massive units act as rigid blocks
Granitoid quartz veins and pegmatites mobilize gold
Stratiform, side, stratabound and step veins
Stratiform, side, stratabound and step veins
Radial veins
Flexural slip discordant veins
Vertical veins
N
S
Zones of shear
Rotation of shear fabric
Crenulation cleavage
Axial planar cleavages
Chlorite/carbonate veins mobilize gold
Reoriented early step fold
Grain alignment cleavage
Granitoid intrusion and ductile shear overprinting earlier Acadian fabrics and veins

Figure 2. General north-south geological section showing relation of gold deposits to regional metamorphism and structure, granitoid intrusion, and late movement on the County Harbour Fault.

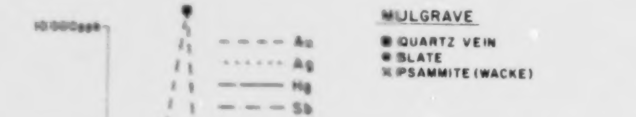


Figure 3. Log-log distribution of Au, Ag, Hg and Sb about auriferous stratiform vein, Mulgrave Mine.

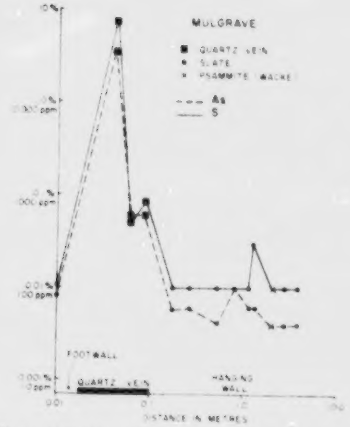


Figure 4. Log-log distribution of As and S about auriferous stratiform vein, Mulgrave Mine.

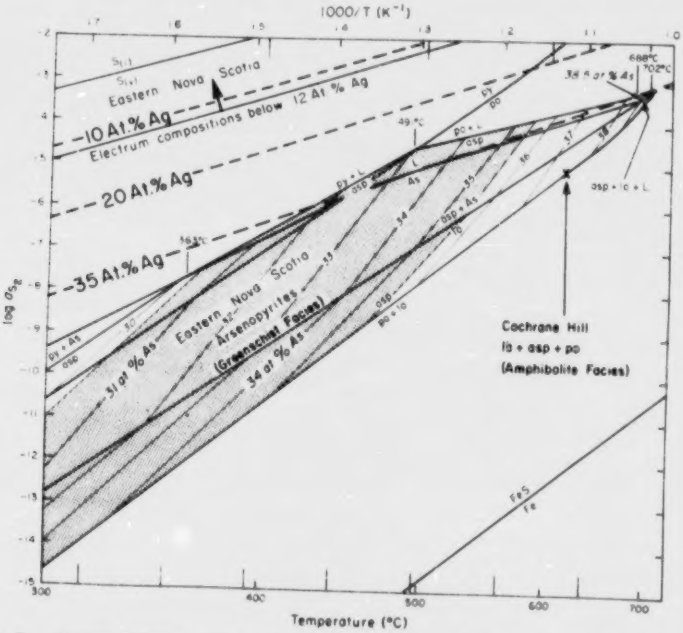


Figure 5. Compositions of arsenopyrites (shaded) and native golds, greenschist facies, eastern Nova Scotia, plotted on log a_{S_2}-temperature diagram. Phase fields from Kretschmar and Scott (1976), and Barton and Toulmin (1964).

compositions (less than 12 atomic per cent Ag) correspond to sulphur fugacities well above the arsenopyrite stability field. Because no argentite was observed, the true sulphur fugacity could not be determined. Therefore the arsenopyrite temperatures lie somewhere below 550°C, the upper limit of the 35.5 atomic per cent As arsenopyrite composition curve (Fig. 5). Ten sphalerites, coexisting with pyrrhotite and pyrite and taken from a 0.5 m length of stratiform vein at Isaacs Harbour, have compositions varying between 9 and 15 mole per cent FeS. This can be interpreted as follows: 1) the pressure during successive metamorphisms varied between $4.5\text{x}10^5$ and $1\text{x}10^6$ kPa (4.5 to 10 kbar; geobarometer of Scott, 1976; Lusk and Ford, 1978); 2) the equilibration temperatures were below 300°C (geothermometer of Scott and Kissin, 1973); or 3) equilibrium was not attained. These pressures (Fig. 6) are unreasonable because the regional low-pressure Pyreneean metamorphism (Keppie and Muecke, 1979) only reaches andalusite, **not** kyanite, at its maximum. Although nonequilibrium cannot be discounted, it is interesting to note that the compositional spread is similar to the natural assemblages at Broadlands used by Browne and Lovering (1973) to derive a natural phase diagram (Fig. 7). Application of this to the Meguma sphalerites yields temperatures of 260 ± 10°C, identical to temperatures (Fig. 8) obtained from fluid inclusion homogenization studies of this vein (Yonover et al., in preparation). Fluid inclusion studies by Yonover (in preparation) indicate that most veins in the greenschist facies have homogenization temperatures of 265 ± 5°C and low salinities (5 to 8 weight per cent NaCl). Capacitance manometer determinations (Fig. 8), following laser decrepitation extraction, revealed high CO_2, with the highest values in stratiform veins and lower values in step veins. In the greenschist facies, several sets of northerly-trending quartz veins (a-c veins of Haynes, 1983) cut, and locally warp, the Acadian axial-planar cleavages. These post-Acadian folding veins display variable homogenization temperatures, salinites and mCO_2 values, with one sample from Seal Harbour yielding a very low salinity of 0.9 weight per cent NaCl (Fig. 8).

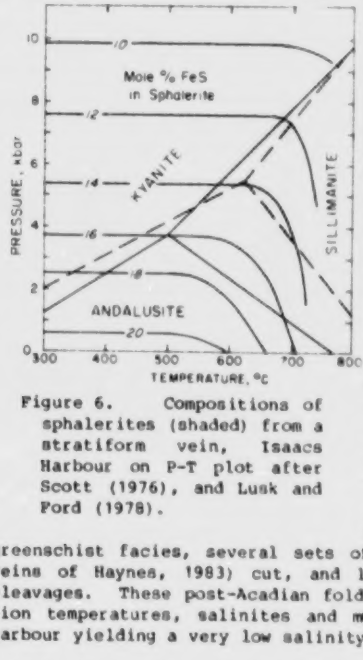


Figure 6. Compositions of sphalerites (shaded) from a stratiform vein, Isaacs Harbour on P-T plot after Scott (1976), and Lusk and Ford (1978).

In the northern sector of the eastern Meguma Terrane (Fig. 2), granitoid intrusions and associated pegmatites and quartz veins have cut and tourmalinized Acadian pressure solution cleavages. At Forest Hill, this event is associated with mobilization of gold. At about the same time, static regional metamorphism overprinted the earlier veins. Subsequently, zones of dextral ductile shear transposed the different earlier veins to bedding-parallel orientations in belts of schist, but preserved many structures in the metawackes, which acted as semirigid blocks. At Forest Hill,

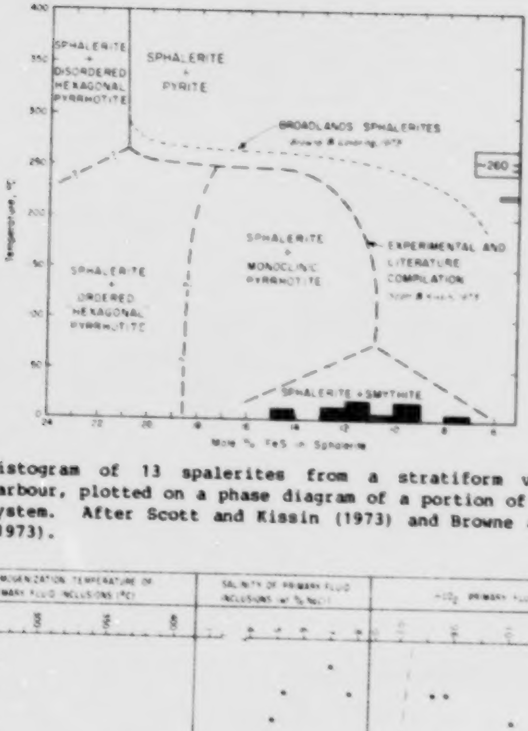


Figure 7. Histogram of 13 spalerites from a stratiform vein, Isaacs Harbour, plotted on a phase diagram of a portion of the Fe-Zn-S system. After Scott and Kissin (1973) and Browne and Lovering (1973).

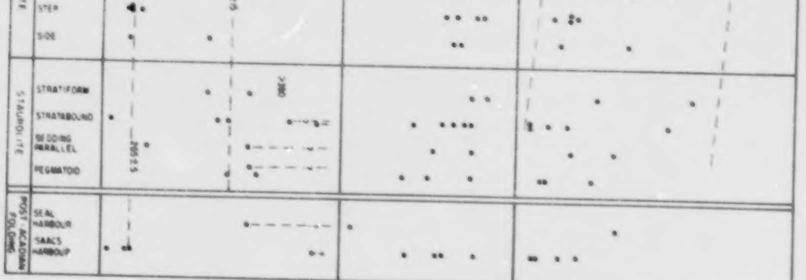


Figure 8. Homogenization temperatures, salinites, and mCO_2 values in primary fluid inclusions in quartz from Meguma gold deposits, relative to quartz vein polytype and metamorphic grade.

the pegmatites exhibit anomalous gold values and native gold was observed in one of them by P. K. Smith (personal communication, 1983). However, due to the postpegmatite transposition of the veins to bedding-parallel orientations (Fig. 2), it is difficult to distinguish granite-related veins from the different types of earlier veins. The amphibolite facies quartz veins at Cochrane Hill (samples collected by P. K. Smith, 1982) exhibit trimodal fluid inclusion homogenization temperatures (Yonover et al., in preparation) of 260°C, 335°C and >350°C, and an overall decrease of mCO_2 values (Fig. 8). Also, a bedding-parallel vein at Cochrane Hill contains arsenopyrites with composition near 37.5 atomic per cent As. One of these is in direct association with loellingite and pyrrhotite (P. K. Smith, personal communication, 1983). These arsenopyrite compositions correspond to a temperature range of 540-670°C (Fig. 5). Although more geothermometric data are needed (currently underway) it is tentatively suggested that the temperatures obtained throughout the study area are a reflection of the effects of successive vein emplacement, metamorphism, granite intrusion and deformation.

The last tectonic event was brittle deformation related to left-lateral movement on the Country Harbour Fault. At Widow Point (Fig. 2) this is associated with chlorite-carbonate veins and breccia fillings and quartz stringers that have locally retrograded the schists. Although new gold may have been introduced at this time, it is more likely that gold was only locally mobilized. Evidence for this is that at Forest Hill (no late brittle deformation), the gold is plastered along the walls of andalusite-bearing quartz veins due to the ductile shear, but at Widow Point, the gold is nuggety in andalusite quartz veins, and the ductile shear fabric has been locally obliterated by the late retrograde alteration.

Preliminary lead isotope analyses of quartz vein galenas (Farquhar and Haynes, in preparation) indicate that the least radiogenic data points lie close to the average terrestrial growth curves and define the mean model age 550 ± 50 Ma. This is consistent with K/Ar ages of 475-500 Ma obtained for two "detrital" muscovites from the Goldenville Formation by Poole (1971), although it does not necessarily preclude remobilization of lead during the Acadian Orogeny dated at 415 to 400 Ma by $^{39}Ar/^{40}Ar$ (Reynolds and Muecke, 1978).

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GOLD POTENTIAL OF THE MEGUMA GROUP: NEW CONCEPTS*

S. J. Haynes and P. K. Smith

Gold in the Meguma Group was traditionally mined from quartz veins preferentially located in the slate units of turbidite sequences. Detailed field studies at Wine Harbour, Isaacs Harbour, Goldboro, Beaverdam, Cochrane Hill and Forest Hill have demonstrated the following new information:

1) At some deposits, gold is present within the host-rock slates as deformed wisps of free gold and native gold inclusions in garnet porphyroblasts. This implies significant potential for increased mining widths of low-grade ore comprising both quartz veins and slate.

2) In greenschist facies zones, eleven different quartz vein polytypes have been characterized on the basis of form, characteristic mineralogy, wall rock alteration and crosscutting relationships to each other and regional structures. However, gold is restricted to structurally early (pre-Acadian) corrugated stratiform veins (exhibiting crosslaminations and columnar structures), boudinaged stratabound veins, and associated small side veins. These are cut by K-feldspar bearing cross-veins, displaying arsenopyritization and sericitization of the wall rocks. The other polytypes, which range from syn- to post-Acadian, are apparently barren.

3) In amphibolite facies zones, Acadian structures are complicated by intrusion of late Acadian granitoids, themselves deformed by at least two post-Acadian (Hercynian?) dynamo-metamorphic events. All quartz vein types common to the greenschist facies appear to be present. In addition, gold is present in both deformed andalusite bearing pegmatoid veins. Late Acadian static metamorphism incorporated gold as inclusions in garnet porphyroblasts. These porphyroblasts are, in turn, cut by deformed auriferous, syn-Hercynian(?), stratiform and stratabound quartz veins. The final stage of gold-quartz deposition appears as undeformed, post-Hercynian(?) crosscutting veinlets.

A polygenetic model for gold is proposed involving initial deposition from submarine hydrothermal vent systems as chemical seawater precipitates, hydrothermal sills and fault-controlled feeders. Later, polyphase Acadian, Hercynian(?) and post-Hercynian(?) dynamo-thermic solutions remobilized both gold and quartz.

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*Presented at the 1983 Atlantic Geoscience Society Symposium on the Origin, History and Potential of Sedimentary Basins in Eastern and Offshore Canada; Atlantic Geoscience Society, Fredericton, New Brunswick, January 1983.

NEW INTEREST IN NOVA SCOTIA GOLD*

S. J. Haynes

Over the past four years, the historic Meguma goldfields of Nova Scotia have been the subject of significant new exploration interest. As the gold camps have been dormant for over forty years, this is the first time that modern geophysical surveys (airborne and ground magnetometer/VLF--EM) and geochemical techniques (e.g. humus Au) have been employed in conjunction with conventional investigations. To date over twenty old camps have been drilled, two shafts reopened, an exploration decline sunk, and three open-cut/test mill operations initiated.

This interest in gold is being actively supported by a joint Federal-Provincial Mineral Development Agreement involving the Department of Energy, Mines and Resources and the Nova Scotia Department of Mines and Energy. On a direct development-related level, this involves financial assistance in heap-leaching gold extraction experiments and in tailings concentration tests. These experiments, which are currently underway, are being carried out to devise new techniques to liberate both free gold and sulphide-hosted gold from crushed rock and tailings. Initial results from these experiments are encouraging.

At the geological research level, Nova Scotia Department of Mines and Energy and Geological Survey of Canada are partners in a two-year research project on the gold metallogeny of the eastern Meguma Zone. The object of this multidisciplinary project is to determine the relationship of gold to the geological history of the area. This involves determination of the regional setting of the gold deposits, in terms of structure, stratigraphy and metamorphism, as well as detailed examination of the gold deposits themselves. Also, the geochemical distribution of gold and the geochronological framework of the area are also being studied.

New results, of importance to exploration, obtained from the first field-season's activities, are as follows:

(1) Although gold was traditionally mined by selective methods from stratabound or stratiform quartz veins, gold is present in many crosscutting veins and also occurs as disseminations in country-rock turbidite sequences. This disseminated gold is present as either wisps of free gold or as inclusions in arsenopyrite and garnet porphyroblasts. This allows consideration of radically increased mining widths accomodating open-pit and/or underground trackless mining operations. As an example, the ore zone at Cochrane Hill, site of Northumberland Mines' heap-leaching/cyanidation mill test operation, is about 20 m wide at surface.

(2) Auriferous quartz veins are present in both greenschist and amphibolite facies zones of regional static metamorphism. In greenschist

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*Abstracts of Papers Presented by Representatives of the Provincial and Territorial Geological Surveys at the March 7-9, 1983, Meeting of the Prospectors and Developers Association, Toronto. Published by the Committee of Provincial Geologists, Provincial Ministers of Mines.

facies zones, eleven different types of quartz veins have been identified, but gold is only related to structurally-early types that predate Acadian deformations, metamorphisms (dynamic and static), and granite intrusion. Most of the gold is related to corrugated stratiform veins (exhibiting crosslamination and columnar structures similar to modern geyserites) associated with crosscutting quartz veins (stratabound veins and high-angle K-feldspar bearing "feeders") often displaying arsenopyritization or sericitization of the wall rocks. In amphibolite facies terranes, deformation of early auriferous veins is more intense and gold has been remobilized during static metamorphism, granitoid plutonism, and later periods of post-Acadian quartz veining and deformation.

(3) The gold districts are preferentially located near the hinge zones of asymmetric, step-form folds. Although "saddle reefs" are present, many vein systems are located on the limbs of folds and may represent zones of continued tectonic reactivation controlling the movement of gold-bearing solutions. The mineralogies and form of the veins, and adjacent wall rock alteration effects, suggest that gold may have been deposited initially from submarine hydrothermal vent systems as chemical seawater precipitates, intrasediment hydrothermal sills and fault-controlled feeders. Polyphase Acadian and post-Acadian (Hercynian?) deformations remobilized both quartz and gold.

Future field work will concentrate on refining structural and stratigraphic relationships. Completion of mineralogical, geochemical, stable isotope and geochronological studies will lead to documentation of the timing and conditions of gold transport and deposition. It is anticipated that these studies will enable establishment of useful exploration models to assist in modern prospecting of this former gold-producing region.

METALLOGENY OF GOLD IN NOVA SCOTIA*

A. K. Chatterjee, S. J. Haynes and M. Zentilli**

ABSTRACT

Regional metallogenic synthesis has revealed that the Nova Scotian gold deposits may be grouped into two major types: (1) gold-sulphide type, and (2) gold-quartz type. The former is restricted to Precambrian volcanic, metasedimentary and plutonic complexes of the Cape Breton terrane and the latter to the Cambro-Ordovician flyschoid rocks of the Meguma terrane. These two terranes are separated by the east-west trending Minas Geofracture.

The gold-sulphide type of mineralization occurs in three distinct domains, viz: (a) Margaree-Middle River Domain, (b) Stirling-Deep Cove Domain, and (c) Coxheath Domain. Each of these has distinctive geological, geochemical and ore characteristics. The north-south trending Margaree-Middle River Domain, hosting stratabound Cu-Pb-Zn sulphides in metasedimentary rocks, is characterized by sericite and biotite alteration, complex paragenetic association among sulphide minerals and, within the mineralized zone, positive correlation of Au with As, Sb, Ni, Ag, Cu, K and CO_2. The gold content of the mineralized samples ranged from 0.8 ppm to 145 ppm; the higher values of Au were restricted to samples containing an arsenopyrite + loellingite + pyrite assemblage. The northeast trending Stirling-Deep Cove Domain is characterized by deformed, bimodal, calc-alkaline volcanic and volcaniclastic rocks. Within this domain the plutonic complexes are polyphase and range in age from Hadrynian to Devono-Carboniferous. Thirty-eight ore samples from this domain have a mean gold content of 0.68 ppm and a mean silver value of 93 ppm. Au is positively correlated with Ti, Th, Zr, Ni, Co, Bi, Mg, Cu, B and CO_2; whereas Ag is positively correlated with Pb, Zn, Sb, Ba, Sr, Ca, Fe and P. The Coxheath Domain is related to a Precambrian hydrothermally-altered gabbro-granite complex, the host rocks for vein type Cu-Mo mineralization. Geochemically, Au is positively correlated with Cu, Ti, Co, Ni, Na Σ7REES and B.

The gold-quartz type, the main past producer of gold in Nova Scotia is hosted by regionally metamorphosed flyschoid sediments and represented by 11 subtypes in six distinct domains characterized by mineralogical and geochemical parameters: (1) Ploymetallic Au:Ag zone, (2) Ag-Au-W zone, (3) Cu-Ag zone, (4) Au-W-Pb zone, (5) Fe-Mn-Zn-Au zone, and (6) Sb-Au-Bi-Pb zone. Although individual deposits within a zone may have relatively simple or complex mineralogy, stepwise multiple discriminant-function analysis of the log-normalized data failed to reveal significant differences in the discriminant scores. R-mode factor analysis suggests that the deposits of individual domains are related to similar geochemical processes operating under slightly different physio-chemical conditions.

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*Canadian Institute of Mining and Metallurgy, 85th Annual General Meeting, Winnipeg, 1983; Program with Abstracts, p. 88.

**Department of Geology, Dalhousie University, Halifax, Nova Scotia.

An integrated study of metallogeny, geochemistry and sulphur isotopes of gold-bearing deposits in Nova Scotia suggests that: (1) the mineralized solutions for the gold-sulphide type were probably derived from mafic magma. The sulphur isotopic fractionation between pyrite-spalerite-galena records a temperature range of 453 ± 10°C to 280 ± 15°C, and suggests that gold precipitation may have been triggered by changes in T, f_{O_2}, pH and the activity of species in solution, all of which are greatly influenced by wall rock alteration reactions, and (2) the mineralizing solutions for the gold-quartz type were either of geothermal and/or metamorphic origin. Arsenopyrite crystallization temperatures record a range of 440 ± 15°C to 368 ± 15°C, whereas sulphur isotope fractionation between coexisting trisulphides record a temperature range of 400 ± 10°C to 300 ± 20°C. Sulphur isotopic determination of 65 vein pyrites indicate that the vein sulphur could not have been derived exclusively from the adjacent sedimentary rocks, nor exclusively from magmatic rocks. Individual domains may have formed by complex polygenetic processes, locally involving some combination of submarine geothermal systems, prefolding (hydraulic fracturing) and synfolding (dilatent) Acadian metamorphogenic solutions, granitoid intrusion, and post-granitoid deformations.

GEOLOGY OF THE SANGSTER LAKE AND LARRYS RIVER PLUTONS*

G. A. O'Reilly

INTRODUCTION

During the 1983 field season, the Sangster Lake and Larrys River granitoid plutons were mapped as part of the Meguma Project of the Canada-Nova Scotia Co-operative Mineral Program, 1981-1984 (Fig. 1). Most of the granitoids of the eastern Meguma Terrane have never been mapped on other than a reconnaissance level, although some have excellent outcrop exposure. An airborne gamma ray spectrometric survey of the eastern Meguma Terrane was completed and released by the Geological Survey of Canada in 1980. This data showed interesting variations in radiometric response over certain granitoids of this region. Ford and Ballantyne (1983) carried out follow-up reconnaissance geological studies and lithogeochemical sampling on these granitoids and determined some of the plutons have enrichment in U, Rb, Be, Sn and Nb and depletion in TiO_2, MgO, CaO, Sr, Ba and Th. This places them in the "specialized granite" class of Tischendorf (1977); these granitoids are therefore of exploration interest as possible precursors to granophile element mineralisation. In particular, the Sangster Lake, Tom

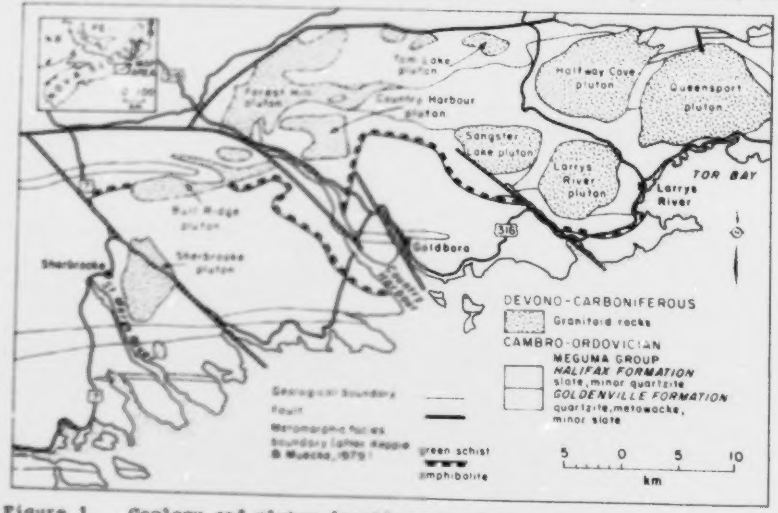
Tom Lake pluton
Forest Hill pluton
Country Harbour pluton
Halfway Cove pluton
Queensport pluton
Sangster Lake pluton
Larrys River pluton
TOR BAY
Larrys River
Bull Ridge pluton
Sherbrooke pluton
Sherbrooke
Goldboro
316
DEVONO-CARBONIFEROUS
Granitoid rocks
CAMBRO-ORDOVICIAN
MEGUMA GROUP
HALIFAX FORMATION
slate, minor quartzite
GOLDENVILLE FORMATION
quartzite, metawacke, minor slate
Geological boundary
Fault
Metamorphic facies boundary (after Keppie & Muecke, 1979)
green schist
amphibolite
5 0 5 10
km

Figure 1. Geology and pluton location map of the eastern Meguma Terrane.

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*Contribution to Canada-Nova Scotia Co-operative Mineral Program 1981-84. Project carried by Nova Scotia Department of Mines and Energy and Geological Survey of Canada.

Lake and Sherbrooke plutons (Fig. 1) appear to have the best economic potential based on the radiometric data and reconnaissance lithogeochemistry.

Previous workers have considered the Sangster Lake and Larrys River plutons as one body connected by a narrow neck of granite (Keppie, 1979). However, on geological mapping and air photo interpretation there is little evidence to support connecting these two plutons, so they will be referred to here as separate discrete bodies. Ford and Ballantyne (1983) referred to the eastern granitoid close to the settlement of Larrys River as the Eastern Brook pluton, but in past literature (Fairbairn et al., 1960),the name Larrys River identified the granitoid terrane in this area, hence the name Larrys River pluton is retained. The Sangster Lake pluton is named for the western pluton which has Sangster Lake at its centre (Fig. 2).

RESULT OF FIELD MAPPING

The geology of the Sangster Lake and Larrys River plutons are shown on Figure 2. The designation of phases is by field identification only, because petrographic and geochemical results are not yet complete.

LARRYS RIVER PLUTON

The Larrys River pluton is a roughly L-shaped body of approximately 36 km^2 (Fig. 2). The western and central regions of the pluton consist of a coarse grained, porphyritic, two mica granodiorite. Biotite predominates over muscovite by about 2:1. The overall rock composition becomes more monzogranitic where less porphyritic areas of this phase occur. Toward the east, the porphyritic granodiorite grades into a coarse grained transitional monzogranite. This transitional phase is much less porphyritic than is the granodiorite, and contains biotite and muscovite in approximately equal proportions. Further to the east and north this transitional phase passes into nonporphyritic muscovite biotite monzogranite. In this phase, muscovite and biotite also occur in approximately equal proportions.

Minor intrusions and dykes of fine- to medium-grained leucogranite occur throughout all phases of the Larrys River pluton. These minor intrusions are often accompanied by small pegmatite intrusions and usually occur within a short distance from the contact with the Meguma Group metasediments. One of these intrusions is large enough to be shown in Figure 2. This small leucogranite intrusion is located northwest of Fougere Lake where it has intruded porphyritic granodiorite and Halifax Formation slates. The leucogranite is cream coloured and fine to medium in grain size. Fine grained muscovite dominates proportionally over biotite with the biotite occuring as irregular wisps giving the rock an inhomogeneous appearance. Although some greisenization and quartz veining are associated with this leucogranite, no mineralization was observed.

SANGSTER LAKE PLUTON

The Sangster Lake pluton is a roughly rectangular shaped body of approximately 25 km^2 (Fig. 2). A number of roof pendants of Goldenville

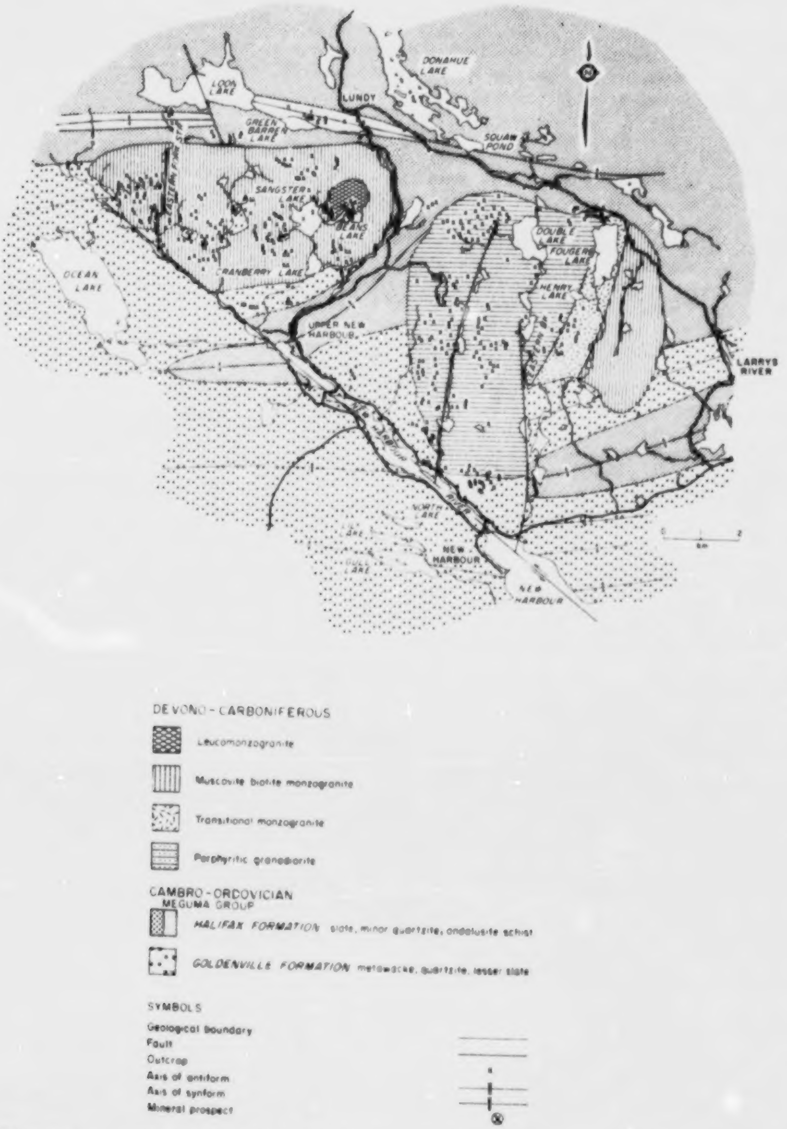
LOON LAKE
GREEN BARREN LAKE
LUNDY
DONAHUE LAKE
SQUAW POND
N
SANGSTER LAKE
BEANS LAKE
CRANBERRY LAKE
OCEAN LAKE
DOUBLE LAKE
FOUGERE LAKE
HENRY LAKE
UPPER NEW HARBOUR
LARRYS RIVER
NEW HARBOUR RIVER
NORTH LAKE
LILY LAKE
GULL LAKE
NEW HARBOUR
NEW HARBOUR
0
2
km
DEVONO - CARBONIFEROUS
Leucomonzogranite
Muscovite biotite monzogranite
Transitional monzogranite
Porphyritic granodiorite
CAMBRO - ORDOVICIAN
MEGUMA GROUP
HALIFAX FORMATION slate, minor quartzite, andalusite schist
GOLDENVILLE FORMATION metawacke, quartzite, lesser slate
SYMBOLS
Geological boundary
Fault
Outcrop
Axis of antiform
Axis of synform
Mineral prospect

Figure 2. Geological map of the Sangster Lake and Larrys River putons.

Formation metasediments occur throughout the southern half of the pluton. One such pendant contains a series of stratabound quartz veins which were prospected for gold in the 1930's. Dump samples from this prospect show the quartz veins to be cut by granitic veins, suggesting a pregranitic origin for the stratabound veins.

The Sangster Lake pluton consists almost entirely of coarse grained, muscovite-biotite monzogranite. The western end of the pluton (the area west of the First Fork Brook Fault) is monzogranite with muscovite and biotite in approximately equal proportions. Toward the east and south there is an increase in the proportion of muscovite to biotite. A small intrusion of muscovite leucomonzogranite, named here the Beans Lake leucomonzogranite, occurs northeast of Sangster Lake. This phase varies in grain size from fine to coarse, but most outcrops are medium grained. Smaller intrusions and dykes of leucomonzogranite-leucogranite occur in other areas of the Sangster Lake monzogranite, but are too small to be indicated on the scale of Figure 2.

The Beans Lake leucomonzogranite is a highly evolved late-stage differentiate that has been subjected, especially in contact zones, to extensive pneumatolytic-hydrothermal alteration. Where exposed, contacts of both the leucomonzogranite and the adjacent monzogranite have been greisenized to varying degrees and contain extensive areas of quartz veins. Although the degree of pneumatolytic-hydrothermal alteration has been high, no significant economic mineralization has been observed to date.

The Sangster Lake pluton exhibits shear related deformational features that vary in intensity throughout the pluton. Along the northern edge, outcrops of the monzogranite display both foliation (S planes) and shear planes (C planes). These features indicate a dextral east-west shear zone exists in this area (see Keppie, this volume, p. 193). Toward the south, the deformation is much less pronounced, with only the S fabric evident. West of the First Fork Brook Fault, the monzogranite is only slightly deformed suggesting this part of the pluton was emplaced late in the deformational history of the area.

The Beans Lake leucomonzogranite is essentially undeformed, although micaceous greisen zones occurring in the contact zones exhibit a strong S plane fabric. This suggests the leucomozogranite was emplaced during the waning stages of the shear deformation, with only the most micaceous units (greisens) taking on a preferred orientation.

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A MULTIVARIATE APPROACH TO GEOCHEMICAL DISTINCTION BETWEEN TIN-SPECIALIZED AND URANIUM-SPECIALIZED GRANITES OF SOUTHERN NOVA SCOTIA*

A. K. Chatterjee, D. F. Strong and G. K. Muecke*****

ABSTRACT

Like most granitoid bodies that host significant granophile deposits, the South Mountain batholith (SMB) of Nova Scotia consists of an earlier suite intruded by a later suite of smaller plutons that are more silicic and peraluminous. The latter generally show a range of other geochemical features that readily identify them as "specialized" and allow for their separation from the earlier "non-specialized" granites. In the case of mineralization associated with the SMB we can go one step further and clearly separate the specialized granites into stanniferous and uraniferous series, which can be identified even where no Sn or U enrichment is present. Although this can be done successfully using simple histograms of a number of elements (Li, P, Sn, and F), we show that combining all elements in discriminant analysis guarantees 100 per cent success in separating the two groups. R-mode factor analysis aids in accounting for the variance within each group, the most important effect being a "biotite factor" because of both its magmatic role and its early breakdown by hydrothermal fluids. The stanniferous series is marked by what we call the "lithophile factor" (heavily loaded by K_2O, P_2O_5, Rb, F, Li and W) and the uraniferous series by a "metallization factor" (loaded by Cu, Sn, Mn and Zn). These can be interpreted in terms of dominantly magmatic processes for the former, and dominantly hydrothermal processes for the latter. Furthermore, we emphasize that the separate suites do exhibit these independent characteristics even without mineralization being present.

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*Canadian Journal of Earth Sciences, 1983, v. 20, p. 420-430.

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***Department of Geology, Dalhousie University, Halifax, Nova Scotia.

RARE EARTH AND OTHER ELEMENT VARIATIONS IN GREISENS AND GRANITES ASSOCIATED WITH THE EAST KEMPTVILLE TIN DEPOSIT, NOVA SCOTIA*

A. K. Chatterjee and D. F. Strong**

ABSTRACT

The East Kemptville deposit is located within a northeast-trending polymetallic tin domain of southwestern Nova Scotia, in which tin occurs in both flyschoid sedimentary rocks and in Devonian granitoids. Cassiterite is found in all rock types of the Davis Lake pluton in the East Kemptville area, but economic concentrations are restricted to greisens and greisenized granitoids, along with a complex assemblage of sulphide minerals. Geochemical studies of 137 samples of the greisens and associated granitoids show a continuum between the two for most major and some trace elements, and a sharp separation between them for others. Rare earth elements (REEs) of 24 samples show a progressive depletion from the granitoid rocks to greisens, with preferential loss of light REEs in the early stages of alteration and near-total loss of REEs in the most tin-rich greisens. Although these data agree qualitatively with observations for other greisens that have been explained by the complexing action of fluorine and other anions, it is probable that other variables, such as fluid/rock ratios, will have to be determined before a complete understanding is possible. Nevertheless, the sensitivity of REEs to alteration processes which might otherwise be missed suggests that they could provide a valuable adjunct to lithogeochemical exploration programs in granitoids.

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*Transaction Institute of Mining and Metallurgy, London: Section (B), in press.

**Department of Earth Sciences, Memorial University, St. John's, Newfoundland.

DEVONO-CARBONIFEROUS MAGMATISM AND EPITHERMAL U-TH-MO±AG±F MINERALIZATION IN THE DEBERT LAKE AREA, EASTERN COBEQUID HIGHLANDS*

A. K. Chatterjee

Anorogenic bimodal volcanic rocks of Devono-Carboniferous age are widely distributed in parts of Cape Breton (Fisset Brook Formation), Antigonish Highlands (McAras Brook Formation), and Cobequid Highlands (Byers Brook Formation). Published literature by various authors suggest that the volcanism was related to extensional tectonics, that basaltic magma was derived from the mantle, and that the rhyolites were derived from the partial melt of the crustal rocks. However, the environment for ore deposition in these rocks is poorly understood. The present study was undertaken to investigate the metallogenic evolution of the Byers Brook Formation.

The Byers Brook Formation in the Eastern Cobequid Highlands has been mapped over most of its areal extent (Donohoe and Wallace, 1982) and was explored extensively by Gulf Minerals during the years 1977-81. The present work is based exclusively on the diamond-drill core from the Debert Lake area which measures approximately 5 km x 1 km.

In the eastern half of the Debert Lake area, the Byers Brook Formation is represented in stratigraphic order as follows: three ignimbrite sheets capped by rhyolitic lavas, five basaltic flows, a chert-siltstone sequence and unconformably overlying basaltic and rhyolitic flows. This volcanic pile is intruded by a large number of dykes and sills (averaging 3.85 dykes per drillhole), a few of which may be the feeder dykes. The entire sequence is approximately 1670 m thick, strikes east-west, and dips steeply towards north.

In the western half of the area, the Byers Brook Formation (≈1100 m thick) is represented by a sequence of polymictic upward fining conglomerate, six basaltic flows, four rhyolite flows, and a large number of dykes and sills ranging in width from less than 1 m to over 60 m. Within this sequence, anorthosite dykes are common. This is the first documentation of anorthositic rocks in the Paleozoic volcanic sequences of the Avalon Zone.

The entire sequence in the Debert Lake area is intruded by the granitoid rocks of the Hart Lake-Byers Lake pluton and rhyolite stocks (domes?), which are in turn intruded by porphyritic diabase dykes.

The epithermal U-Th-Mo±Ag±F mineralization occurs in high level intrusive stockworks and collapse breccias, both in the rhyolite dome and the fractured volcanic and volcaniclastic rocks. The mineralization occurs exclusively in zones which have witnessed intensive alkali metasomatism. Characteristically, the metasomatized rocks are in the 61-67% SiO_2 range, thus partially filling the "Daly gap". The fluorine-rich alkali basalts contain cassiterite and may be potential economic hosts for volcanogenic tin mineralization. The Na-rich hornblende granite (containing >5% normative acmite) may be a potential host for Zr, Y and possibly Nb, Ta and REES.

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*Contribution to Canada-Nova Scotia Co-operative Mineral Program 1981-84. Geological Survey of Canada, Project No.: 830032

In summary, it is postulated that (1) the volcanism was triggered by magma mixing, (2) the volcanic rocks represent a zoned magma chamber, and (3) the epithermal mineralization was related to late stage magmatic activity represented by intrusive rhyolite dome(s). The alkali metasomatism in rocks is a diagnostic guide to mineralization.

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PETROLOGY AND GEOCHEMISTRY OF DEVONO-CARBONIFEROUS VOLCANIC ROCKS OF NOVA SCOTIA*

J. Dostal, J. D. Keppie and C. Dupuy*****

ABSTRACT

The Devono-Carboniferous volcanic rocks of Nova Scotia include Middle Devonian basalts from the McAras Brook Formation in the northern Antigonish Highlands (Ballantynes Cove and McAras Brook areas), Middle Devonian and Carboniferous basalts and rhyolites of the Fountain Lake Group in the Cobequid Highlands and the Late Devonian-Early Carboniferous basalts and rhyolites of the Fisset Brook Formation in Cape Breton Island. The volcanic rocks were extruded upon the continental crust in an intraplate setting. The basalts are tholeiitic except those from Ballantynes Cove which are alkaline. All these basalts could have been derived from a similar upper mantle source - garnet peridotite. Rhyolites were probably generated by crustal anatexis related to the ascending basaltic magma. The Devono-Carboniferous volcanism is probably connected with rifting along faults bounding the Magdalen pull-apart basin. In the Cobequid Highlands, the volcanism appears to be spatially and temporally associated with plutonism.

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*Maritime Sediments and Atlantic Geology, 1983, v. 19, p. 59-72.

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URANIUM AND THORIUM IN PALEOZOIC RHYOLITES OF NOVA SCOTIA*

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ABSTRACT

The concentrations of U and Th in Paleozoic rhyolites of Nova Scotia are closely related to their contents of K. The rhyolites were affected by secondary processes including low-grade metamorphism that could lead either to enrichment or depletion of these elements. The average abundances of U (ppm), Th (ppm), and K (%) in rhyolites are: Cambrian - 2.69, 9.77, and 2.58, respectively; Silurian - 4.50, 17.3 and 4.09, respectively; and Devono-Carboniferous - 4.64, 18.3 and 5.67, respectively. The depletion of U, Th, and K in Cambrian rocks compared with younger Paleozoic rhyolites is probably related to secondary processes. In Silurian and Devono-Carboniferous rhyolites, these elements were mainly redistributed during the secondary processes, but not removed.

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*Canadian Journal of Earth Sciences, 1983, v. 20, p. 266-274.

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GEOLOGY OF THE IGNEOUS-METAMORPHIC COMPLEX OF SHELBURNE AND EASTERN YARMOUTH COUNTIES, NOVA SCOTIA*

H. D. Rogers and C. E. White****

ABSTRACT

Fieldwork completed during 1983 in Shelburne County and adjacent parts of Yarmouth County indicates that the granitoid intrusions in the western part of the area are part of a single tonalite pluton (Barrington Passage pluton). Metasedimentary rocks along its margin are largely migmatized. A 2 km wide septum of metasedimentary rocks separates it from the Shelburne pluton to the east. The Shelburne pluton consists of granite and trondhjemite which is bounded on the south and east by psammites and on the north by porphyroblastic andalusite-biotite schists. Small diorite, diabase and granite intrusions are also present. East and west of the plutonic area are major synclines containing a unique assemblage of porphyroblastic andalusite-cordierite-staurolite schists and granofelses.

INTRODUCTION

The project area lies in southwestern Nova Scotia in Shelburne and Yarmouth counties (Fig. 1). Covering an area of 3200 km^2, it includes parts of NTS sheets 21A/3,4 and 20P/5,6,11,12,13,14. Although outcrop is best in coastal sections, adequate exposures occur in most inland areas. Access to these inland areas has improved considerably during the last twenty-five years, due largely to an increase in logging activity and recreational use. Combined with extensive waterways and trails these partly compensate for the large areas of stunted bush and swamp.

The geology of the project area is apparently unique within the Meguma Zone of the Appalachians because of the spectacular development of porphyroblastic andalusite, cordierite and staurolite resulting from local amphibolite facies regional metamorphism (Chu, 1978). Unusual too is the widespread development of migmatite in the area. The granitoid lithologies such as tonalite, trondhjemite and high potassium diorite (de Albuquerque, 1977, 1979) contrast with those elsewhere in the Meguma Zone. The granitoid rocks are also characterized by the pervasive development of an apparently syntectonic foliation that has gone largely unnoticed. These various features contrast strongly with those of other areas of the Meguma Zone.

The first systematic mapping of the project area was done in 1959 and 1960 on a reconnaissance scale of 1 inch = 4 miles (Taylor, 1967). The

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*Also *in* Current Research, Part A, Geological Survey of Canada, Paper 84-1A, p. 463-465, 1984.
Contribution to Canada-Nova Scotia Co-operative Mineral Program 1981-84. Project carried by Geological Survey of Canada.
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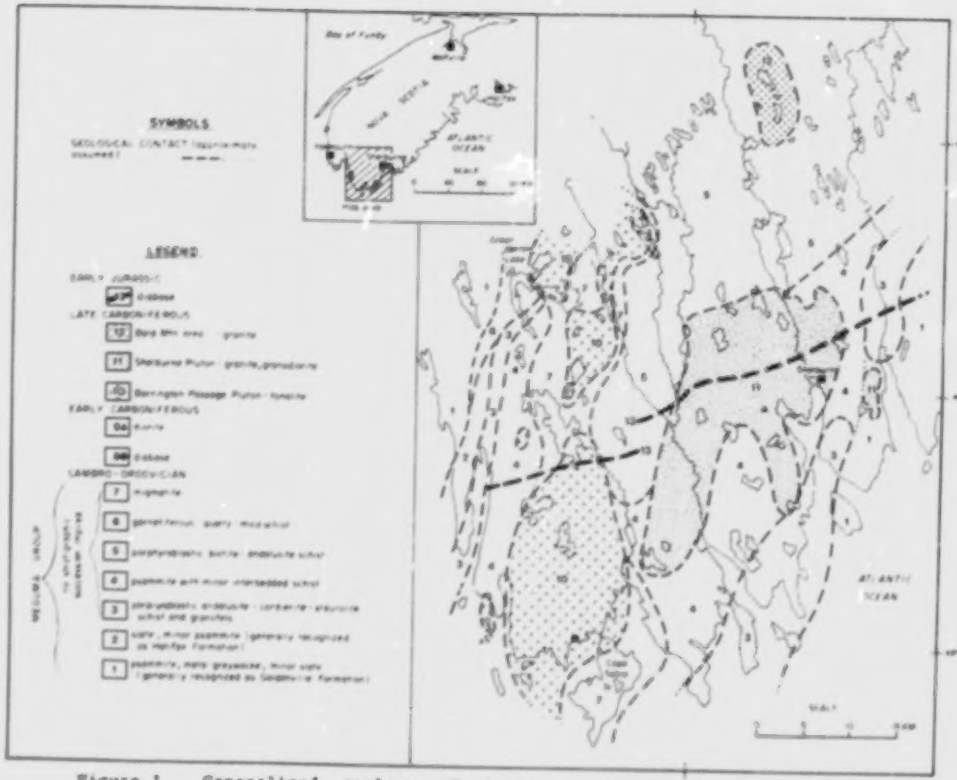
SYMBOLS
GEOLOGICAL CONTACT (approximate, assumed)
LEGEND
EARLY JURASSIC
Diabase
LATE CARBONIFEROUS
12
Shelburne Pluton - granite, granodiorite
Barrington Passage Pluton - tonalite
EARLY CARBONIFEROUS
Diabase
CAMBRO-ORDOVICIAN
7 migmatite
6 garnetiferous quartz - mica schist
5 porphyroblastic biotite - andalusite schist
4 psammite with minor interbedded schist
3 porphyroblastic andalusite - cordierite - staurolite schist and granofels
2 slate, minor psammite (generally recognized as Halifax Formation)
1 psammite, meta greywacke, minor slate (generally recognized as Goldenville Formation)
MEGUMA GROUP
Bay of Fundy
NOVA SCOTIA
ATLANTIC OCEAN
SCALE
ATLANTIC OCEAN
SCALE

Figure 1. Generalized geology of igneous and metamorphic rocks of Shelburne County and eastern Yarmouth County.

geochemistry and evolution of plutonic rocks in the area were described by de Albuquerque (1977, 1979). K/Ar and $^{40}Ar/^{39}Ar$ geochronology of these granitoid rocks was reported by Reynolds et al. (1981). These data indicated young ages of 302 and 308 Ma for the larger plutons - another distinctive feature of this area compared to elsewhere in the Meguma Zone.

The lack of detailed mapping in the area led to the development of this project and fieldwork commenced in May 1983. A further season of fieldwork is planned for 1984. Results of the mapping, combined with petrological studies emphasizing the granitoid rocks, will form the basis of a M.Sc. thesis by the first author. Metamorphic aspects of the area will be studied by field assistants doing B.Sc. (Honours) theses at Acadia University.

METASEDIMENTARY LITHOLOGIES

The eastern and western limits of the map area are defined by the occurrence of "normal" (greenschist facies) Meguma Group lithologies. On the east this occurs to the east of Jordan Bay, and on the west to the western side of the Pubnico Peninsula (Fig. 1). Only Goldenville Formation (Unit 1) is present within the map area on the eastern side whereas both Goldenville Formation and overlying Halifax Formation (Unit 2) occur on the western side. Both Formations are metamorphosed to the biotite grade of the greenschist facies (Keppie, 1979). The Goldenville Formation consists mainly of thickbedded psammites with minor interbedded slate. The Halifax Formation consists of highly cleaved slate with minor interbedded psammite.

Along the inner margins of these units occur major synclines containing highly aluminous pelitic schists and granofelses (Unit 3), noteworthy for high concentrations of andalusite, cordierite and staurolite porphyroblasts. Within the remaining area between the synclines are a varied group of metasedimentary lithologies which have been subdivided into four groups (Fig. 1). Unit 4 consists primarily of thick-bedded psammites with rare interbedded porphyroblastic, biotite-rich, andalusite schist. This unit is confined to the southern part of the map area in the vicinity of the coastline. The rocks of Unit 5 consist primarily of biotite-rich, porphyroblastic andalusite schist, with andalusite crystals from 10 to 30 cm long being common. Minor, relatively thick (several metres) beds, of semipelite also occur in this unit, which is confined to the northern part of the map area.

A low grade, quartz-rich, garnetiferous schist (Unit 6) outcrops along the northwestern shore of great Barren Lake.

Extensive areas of migmatite (Unit 7) are superimposed on these other units, primarily on the eastern and northern margins of the Barrington Passage pluton. The type and degree of migmatization is highly variable, appearing to depend primarily on local conditions such as host rock composition.

INTRUSIVE ROCKS

The Barrington Passage pluton (Taylor, 1967), covering an area of approximately 1300 km^2 (Fig. 1), is the largest pluton in the map area.

The granitoid rocks described by Taylor (1967) north of Great Pubnico Lake are petrologically similar to the main body of the pluton and are included with it. The pluton consists of strongly foliated, equigranular, biotite tonalite of homogeneous composition. Its intrusion at above minimum-melt temperatures (de Albuquerque, 1977) probably explains the extensive development of migmatite along its borders. A septum of metasedimentary rocks 2 km wide separates it from the Shelburne pluton to the east.

The Shelburne pluton (Taylor, 1967) was originally described as consisting of granodiorite. However, Clarke and Muecke (1980) described it as a trondhjemite. Preliminary results from this study indicate that much of its western portion may be granite. Like the Barrington Passage pluton it possesses a strong foliation and is equigranular. Both muscovite and biotite are characteristically present. The pluton is also characterized by widespread, large scale development of simple pegmatites along its margins. Migmatite has not been found in the vicinity of the Shelburne pluton.

The presence of a large pluton in the Bald Mountian area (Fig. 1) has been confirmed during this study by the mapping of nine new outcrops. It is similar in outcrop to the Shelburne pluton, and preliminary geochemical results indicate a granite composition. Pegmatite development is minimal.

Other smaller bodies of intrusive rock also occur in the map area. A small mafic body (Unit 8) occurs at Murray Cove within the Barrington Passage pluton (Fig. 1). Taylor (1967) described it as gabbro and de Albuquerque (1979) as norite. Diabase is an adequate field term. On one of the islands in the cove this mafic rock is highly shattered and rafted by intrusive tonalite of the Barrington Passage pluton. This places an upper age limit of Late Carboniferous on its intrusion.

Unit 9 is a small (<0.5 km^2) body of massive, high-potassium diorite (de Albuquerque, 1979), within the Shelburne pluton near Birchtown, that was formerly quarried for ornamental stone. Taylor (1967) described it as a hornblende diorite. Age dating by Reynolds et al. (1981) assigned an age of 350 to 353 Ma. Taylor (1967, p. 44) referred to the fact that a number of holes drilled in the quarry in the early 1940s all passed into "grey granite" at depths as shallow as twenty-five feet. The conclusion of de Albuquerque (1979) that this pluton acquired its anomalous potassium content by contamination from granitic magmas, when combined with its age date, suggests that it was incorporated into the Shelburne pluton during intrusion. Thus, it can be explained as a large xenolith.

The Shelburne Dyke (Unit 13) is a major geological feature extending for several hundred kilometres across southwestern Nova Scotia (Papezik and Barr, 1981). Two new outcrops of this diabase dyke have been found in the map area. Their location lies along the axis of the aeromagnetic high associated with other parts of the dyke.

STRUCTURE

Folding has occurred on a regional scale producing tight, isoclinal folds, which are locally overturned. Highly erratic folding on the mesoscopic scale is common within and adjacent to the migmatites.

No evidence has yet been found of major faulting in the area. Small-scale faulting with well developed slickensides is common in the granitoid rocks, especially those of the Shelburne pluton. Friable fault zone rocks are also found in both the Shelburne and Barrington Passage plutons.

METAMORPHISM

Metamorphic grade varies from greenschist to low pressure, middle amphibolite facies. Isograds have not yet been defined, but typical maximum metamorphic assemblages include some of staurolite, cordierite, andalusite or sillimanite, muscovite, plagioclase, biotite and quartz.

DISCUSSION

Mapping has so far demonstrated that erosion has proceeded to a depth where it is just beginning to penetrate the roof of the northern part of the Barrington Passage pluton. This is evident from the distribution of tonalite in the high grade schists and migmatites in the northwestern part of the map area (Fig. 1). The uniform, south-dipping erosional surface has penetrated lower into the stratigraphic sequence in the coastal region, thus exposing a much greater expanse of tonalite south of Great Pubnico Lake and a greater lateral extent of migmatite on Cape Sable Island. The widespread occurrence of schists in the north and psammites in the south can also be explained by erosional bevelling of the original stratigraphic contact between the Halifax Formation (schists) and the Goldenville Formation (psammites), thus correlating Units 3 and 5 with the Halifax Formation and Unit 4 with the Goldenville Formation. Continued mapping and petrographic studies should lead to a more definitive interpretation of the stratigraphic sequence in the area.

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GEOLOGY OF THE INGONISH RIVER-WRECK COVE AREA, CAPE BRETON ISLAND, NOVA SCOTIA

R. P. Raeside, S. M. Barr and W. Jong

ABSTRACT

The Ingonish River-Wreck Cove area of the eastern Cape Breton Highlands displays three north-south trending belts of contrasting geology. The western belt is composed of high grade orthogneiss and paragneiss. Separated from it by a major mylonite zone is a central belt of varied metasedimentary and metavolcanic rocks, deformed into a major synclinorial structure, and metamorphosed from greenschist to upper amphibolite facies. The eastern belt includes at least nine separate granitoid plutons, ranging from diorite to granite. Ages of many of the units are unknown, but predate the Siluro-Ordovician Cape Smoky pluton, confirming an interpretation of pre-Acadian Taconic or Cadomian orogenesis in Cape Breton Island.

INTRODUCTION

The Highlands of Cape Breton Island contain one of the largest segments of crystalline Precambrian and Paleozoic rocks in the Atlantic Canada section of the Appalachian mountian belt. This segment occupies a critical geographic positon in the orogen because many of the basement rocks in Atlantic Canada are either buried beneath younger sedimentary rocks or under water. The Highlands area has potential for providing critical stratigraphic and structural information concerning the tectonic development of this portion of the orogen. Detailed mapping in 1983 in the Ingonish River and Wreck Cove Hydro-electric project areas represents the first phase of a remapping of the eastern Cape Breton Highlands and has resulted in the compilation of a 1:50 000 scale geological map, a reduced version of which is shown in Figure 1.

Previous maps of this area (McLaren, 1956a, b; Neale, 1963a, b, 1964) are of a reconnaissance nature, and serve to outline the approximate positions of major rock types. No detailed analyses of stratigraphy, structure, metamorphism or plutonic sequences were provided. A regional compilation (Keppie, 1979) shows much of the map area to be underlain by undifferentiated gneisses and schists, undivided George River Group paragneisses and schists, unnamed metavolcanic rocks and a single diorite body of questionable Hadrynian age. In their preliminary 1:250 000 compilation of the entire Cape Breton Highlands, Jamieson and Craw (1983) have attempted to subdivide the Precambrian rock units. However, their map units in the vicinity of Ingonish River and Wreck Cove largely follow those of Keppie (1979) because this area lies outside the area which they have remapped. Other relevant studies have focussed on smaller areas in the Cape Breton Highlands (e.g. Wiebe, 1972; Murray, 1977; Macdonald and Smith, 1980; and Currie, 1982).

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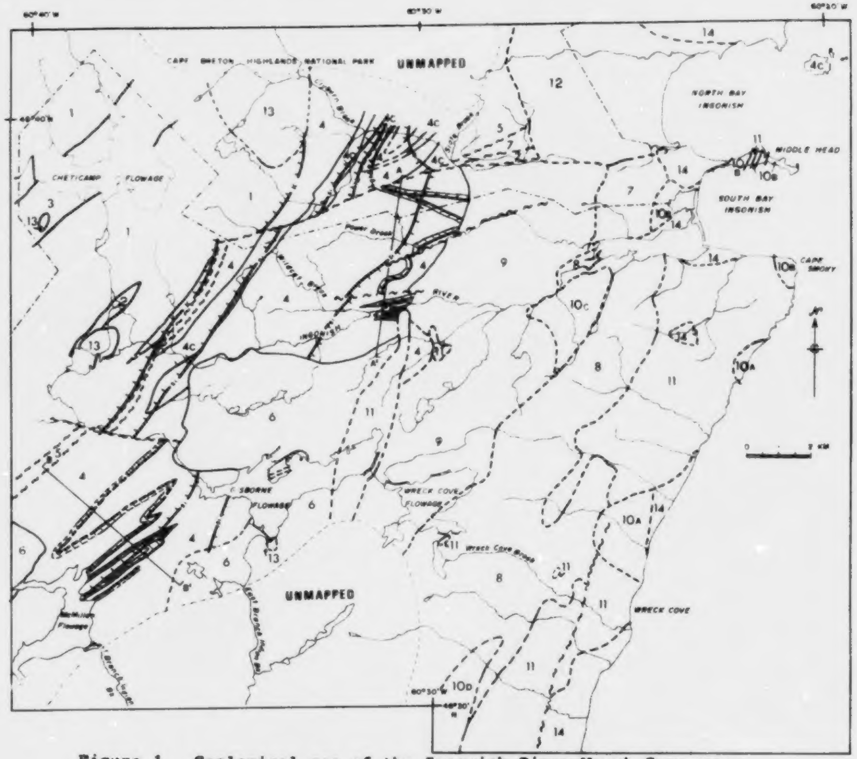
60°40' W
60°30' W
60°20' W
46°40' N
CAPE BRETON HIGHLANDS NATIONAL PARK
UNMAPPED
NORTH BAY INGONISH
SOUTH BAY INGONISH
MIDDLE HEAD
CAPE SMOKY
CHETICAMP FLOWAGE
INGONISH RIVER
OSBORNE FLOWAGE
WRECK COVE FLOWAGE
Wreck Cove Brook
WRECK COVE
East Branch Ingonish R.
UNMAPPED
60°30' W
46°30' N
0
2 KM
1
3
13
4
4C
5
6
7
8
9
10A
10B
10C
10D
11
12
14

Figure 1. Geological map of the Ingonish River-Wreck Cove area.

LEGEND

14 Carboniferous sedimentary rocks (Windsor and Horton Groups)

13 Devonian Clyburn Brook muscovite granite and related rocks

12 Devonian Cameron Brook megacrystic granite

11 Ordovician(?) Cape Smoky biotite granite

10 Ordovician(?): various plutons of undetermined relative age. 10A, Cape Smoky quartz monzonite; 10B, Middle Head leucodiorite; 10C, Ski Hill granodiorite; 10D, Southern granodiorite.

9 Ordovician(?) Ingonish River tonalite

8 Pre-Ordovician Dioritic Complex

7 Pre-Ordovician gneissic tonalite and mafic to felsic gneisses

6 Pre-Ordovician micaceous diorite

5 Undifferentiatd metamorphic rocks (mylonitized where mapped)

4 Ingonish River metasedimentary unit - mainly semipelitic. Black - quartzite layers; hachured - calcareous layers; 4c-mafic layers.

3 Pelitic K-feldspar gneiss

2 Foliated granite

1 Orthogneiss and interlayered semipelitic gneiss

METAMORPHIC BOUNDARIES AND OTHER SYMBOLS

Appearance of biotite ....-bi-
Appearance of garnet ....-gt-
Actinolite + albite + chlorite = hornblende + plagioclase ....-hb-
Staurolite + muscovite + quartz = sillimanite + garnet + biotite ..-si-
Quartz + muscovite = K-feldspar + sillimanite ....-K-

Geological boundary (approximate, assumed) .... —— – – –
Metamorphic boundary (ticks on high grade side) .... ┴┴┴┴┴┴┴
Fault (approximate, assumed) .... 〰 ~ ~ ~

ACKNOWLEDGMENTS

The authors gratefully acknowledge financial support from the Natural Sciences and Engineering Research Council of Canada. The co-operation of Parks Canada in providing access to the Cape Breton Highlands National Park and of the Nova Scotia Power Corporation in permitting use of their private road network and aqueduct tunnel surveys is also appreciated.

OVERVIEW

Three north-south trending belts of diverse lithologic character were mapped in the Ingonish River-Wreck Cove area (Fig. 1). The western belt is composed of interlayered ortho- and paragneisses which have undergone at least two phases of penetrative deformation. The central belt is composed of a package of pelitic, semipelitic, psammitic and calcareous metasedimentary rocks with interbedded tuffaceous and basaltic layers. The eastern belt consists entirely of varied granitoid rocks.

THE WESTERN BELT - THE CENTRAL CAPE BRETON HIGHLAND GNEISSES

The western belt includes ortho- and paragneisses of undetermined age. The major rock type is a monotonous felsic biotite-K-feldspar gneiss, with some garnet-bearing horizons. Throughout the area, the gneiss is monzogranitic in composition, medium grained and poorly foliated. It contains rare lenses of coarse grained biotite-rich schist, up to 10 cm thick. In the headwaters of the Ingonish River, two extensive lenses of coarse grained red-weathering syenogranite outcrop. Possibly infolded into the major orthogneiss unit is a 2 km wide belt of pelitic gneisses, commonly containing garnet, K-feldspar, and less commonly sillimanite.

The metamorphic grade of the Cape Breton Highland gneisses is uniformly above the K-feldspar + sillimanite isograd. Muscovite is present only as large platy poikiloblastic retrogressive grains. Three phases of deformation can be recognized by microfabrics. An early penetrative schistosity, S_1, preserved mainly in garnet porphyroblasts, is almost completely overprinted by a later penetrative schistosity and gneissic foliation, S_2, which is approximately vertical, striking at 055°. Minor isoclinal fold hinges define a mean fold axis at 047°/30°. No macroscopic folds have yet been identified, although the consistent orientation of schistosity and foliation indicate that any possible folding is isoclinal. A third phase of deformation is responsible for minor crenulation cleavages (S_3), generally oriented approximately north-south.

The central Cape Breton Highlands gneisses are intruded by two phases of igneous rocks. The West Branch Indian Brook diorite, a foliated micaceous diorite, and possibly a northern extension of the Baddeck Lakes Diorite of Jamieson and Doucet (1983), outcrops in the southwest of the map area (Fig. 1). The foliation is parallel to the S_2 phase of foliation in the gneisses, but the contact does not appear to be deformed. This indicates that the second deformation phase of the gneisses resulted only in the production of a penetrative fabric. A muscovite-biotite granite outcrops in the headwaters of Clyburn Brook, and as smaller plutons south of Cheticamp Flowage. This is a medium grained, equigranular pink granite, the Clyburn Brook pluton of Wiebe (1975), and is assumed to be temporally related to the Devonian Warren Brook, Black Brook and White Point plutons, to the north (Wiebe, 1975; Barr et al., 1982). The margins of the Clyburn Brook pluton, and related bodies, are diffuse, being marked by large quantities of fine- to medium-grained granitic dykes. Numerous crosscutting granitic dykes are observed in many outcrops of the central Cape Breton Highlands gneisses and their presence can usually be linked to the proximity of these posttectonic granitic plutons.

THE CENTRAL BELT - THE INGONISH RIVER METASEDIMENTARY UNIT

The central belt of the area mapped includes a series of clastic and carbonate metasedimentary rocks and mafic volcanic and volcaniclastic rocks, which have previously been correlated with the Hadrynian George River Group (Wiebe, 1972; and Murray, 1977). The scarcity of carbonate and quartzite rocks in this unit compared to George River Group sections in southern Cape Breton Island (Milligan, 1970) makes this correlation suspect. The western margin, south of the Clyburn Brook Fault is a major mylonite zone or shear zone, 200-600 m wide, in which foliation has been transposed to the orientation of the shear zone and mineral assemblages have been reset in the lower greenschist facies. North of the Clyburn Brook Fault, the contact between the central and the western belts is less well displayed. No outcrops of mylonite or severely retrogressed and sheared rocks were observed, but an isograd can be inferred using the reaction quartz + muscovite = K-feldspar + sillimanite with the higher grade microcline-sillimanite assemblages observed only on the western side.

The major rock type in the Ingonish River metasedimentary unit is a semipelitic schist, typically migmatized, and commonly containing garnet, biotite, sillimanite ± staurolite. More pelitic and psammitic layers can also be recognized. The most important marker horizon is a 50-80 m wide pair of marble and quartzite which are prominent lithologies in the McMillan Gisborne Flowages area, and the interfluve between Power and Clyburn Brooks. The presence of this distinctive pair permits correlation between the central and southern sections of the Ingonish River metasedimentary unit, which are separated by the Gisborne Flowage diorite and by a north-dipping normal fault along the East Branch Indian Brook. A prominent amphibolite horizon, up to 800 m thick, can be traced along the western margin of the Ingonish River metasedimentary unit and across the Clyburn Brook Fault. At lower metamorphic grades, in the Clyburn Brook area, the amphibolite is represented by volcaniclastic breccias, tuffs and aphanitic flows.

Intruded into the Ingonish River metasedimentary unit is the Gisborne Flowage diorite, correlative to the West Branch Indian Brook diorite. Like it, this diorite displays the regional foliation, with no accompanying deformation of its contacts, indicating that it was probably intruded near the metamorphic climax, and during the development of the S_2 schistosity. The most common rock type is a coarse grained biotite-hornblende diorite, but there are leucocratic, melanocratic and quartz-bearing varieties. K-feldspar is universally absent.

The marker horizons outline well the complex deformation effects of the Ingonish River metasedimentary unit (Fig. 2). The earliest phase of deformation produced a regional northeast-southwest trending fold phase and

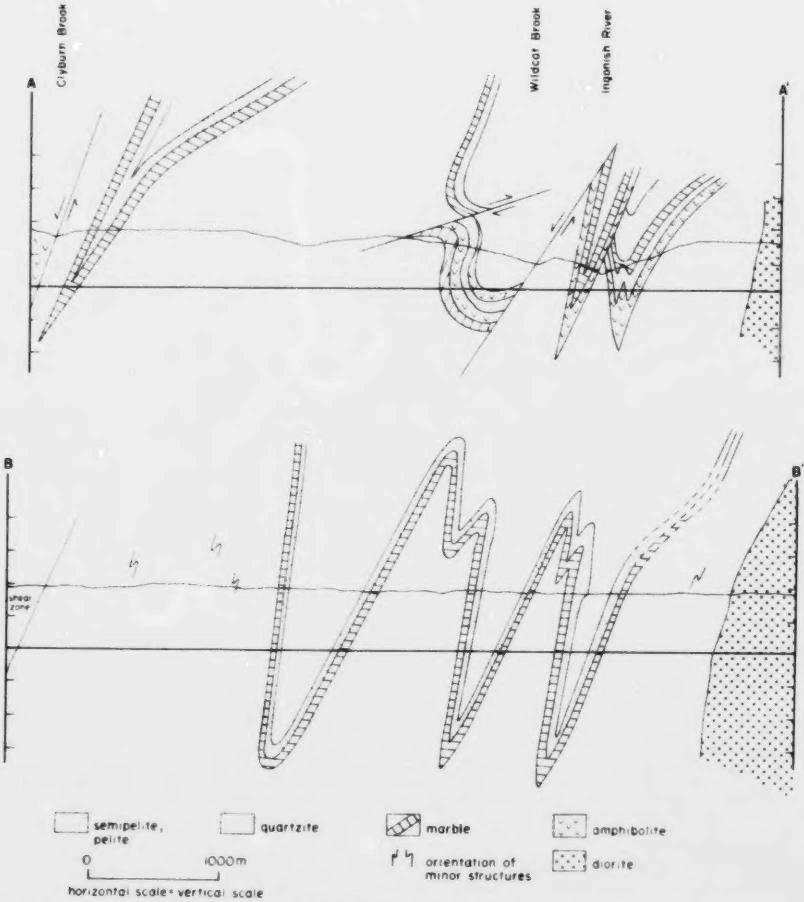
A
Clyburn Brook
Wildcat Brook
Ingonish River
A'
B
shear zone
B'
semipelite, pelite
quartzite
marble
amphibolite
0
1000m
horizontal scale = vertical scale
orientation of minor structures
diorite

Figure 2. Cross-sections along lines A-A' and B-B' on Figure 1. Section A-A' is a vertical cross-section, section B-B' is a right section oriented at 130/60° NE.

a foliation equivalent to the S_2 fabric of the western belt. South of the East Branch Indian Brook Fault these folds are isoclinal, have an amplitude of 5 km, plunge to the southwest and are overturned to the northwest. Between the East Branch Indian Brook and Clyburn Brook Faults, the thick amphibolite outlines a major southwesterly plunging syncline. In the eastern part of this segment of the Ingonish River metasedimentary unit, the preponderance of irregular smaller folds separated by faults and thrusts probably represents the contortions of accommodation in the core of the major fold. Fold axes tend to be westerly, but swing to a northeast-southwest orientation away from the fold core. North of the Clyburn Brook Fault the folds are tight synclines. The absence of isoclinal folds reflects the simpler style of deformation at the lower metamorphic grade represented in this area.

The axial planar foliation of the large scale folds is termed S_2, using the nomenclature established from the western belt. A parallel foliation is also displayed by the East Branch Indian Brook micaceous diorite and other adjacent igneous rocks. As noted previously, the margins of these plutonic bodies are not involved in the folds. It appears therefore that the diorite was intruded after the large scale folding, but before or during the development of the D_2 regional foliation. D_1 and D_2 deformation phases must therefore have been coplanar.

Metamorphic grade ranges from the chlorite grade of the greenshcist facies to a peak in the upper amphibolite facies. Five metamorphic zones can be mapped based on the presence of various mineral assemblages. The lowest grade is the chlorite zone, which outcrops in Clyburn and Slate Brooks and vicinity. Grade rapidly increases up Clyburn Brook through the biotite zone, marked by the development of biotite porphyroblasts in slates, the garnet zone, marked by the development of garnet porphyroblasts in phyllites, to the staurolite zone, in which staurolite and garnet are present in phyllites and schists. The first appearance of staurolite appears almost coincident with the first appearance of hornblende and plagioclase from the breakdown of chlorite, actinolite and albite in mafic rocks. The first appearance of sillimanite has not been accurately defined, however staurolite + sillimanite assemblages are characteristic throughout the staurolite zone. Staurolite disappears by the reaction staurolite + muscovite + quartz = sillimanite + garnet + biotite + H_2O in the upper reaches of Clyburn Brook.

Throughout the central and southern blocks, sillimantite is ubiquitous in aluminous rocks. Staurolite + sillimanite-bearing assemblages only exist in a central lower grade metamorphic depression extending the entire length of the map area.

The Ingonish River metasedimentary unit is cut by a series of faults. These are generally oriented east-west to ENE-WSW. The most prominent of these is the Clyburn Brook Fault, which appears to be a hinged normal fault, having little displacement and a narrow zone of brecciation and mylonite in the west, and extending to a 1 km wide zone of mylonite and severely cataclased rocks in the east, where chlorite-grade rocks are juxtaposed against sillimanite-grade rocks near Clyburn Brook.

THE EASTERN BELT

The eastern belt consists entirely of granitoid rocks, nonconformably overlain locally in coastal areas by Carboniferous sedimentary units (Fig. 1). The inferred intrusive sequence is gneissic tonalite/orthogneiss, dioritic complex, Ingonish River tonalite, small intermediate plutons (Southern granodiorite, Ski Hill granodiorite, Middle Head leucodiorite, Cape Smoky quartz monzonite), Cape Smoky biotite granite, and Cameron Brook megacrystic granite. Previous maps of the area (e.g. MacLaren, 1956b; Wiebe, 1972) did not separate the gneissic tonalite/orthogneiss, dioritic complex and Ingonish River pluton.

The Cameron Brook megacrystic granite is probably Devonian in age, like the Warren Brook, Black Brook and White Point plutons to the north (Cormier, 1972, 1980; Wiebe, 1975) and the Clyburn Brook granite to the west. However, the other intrusions are Siluro-Ordovician or older, based on a Rb/Sr isochron age of 447 ± 37 Ma from the Cape Smoky pluton (Cormier, 1980). All are probably younger than the micaceous diorite of the central belt, previously described.

The gneissic tonalite/orthogneiss occurs in two areas north and south of Clyburn Brook. They are primarily tonalitic in composition, with some granitic bands and contain a small body of cataclased granite with distinctive blue quartz on the southern side of Clyburn Brook. The unit is separated from the Ingonish River tonalite because of the more varied composition of the gneissic tonalite/orthogneiss and abrupt contacts between them (although an actual intrusive contact was not observed). They may be remnants of an old igneous terrane, perhaps related to the "coastal gneisses" of Wiebe (1972). These rocks are highly cataclased and mylonitized in the vicinity of Clyburn Brook, where they are clearly intruded by the Cameron Brook pluton.

The dioritic complex consists primarily of medium grained quartz diorite, but ranges, even within a single outcrop, from diorite to granodiorite of varied grain size (fine to coarse) and texture (equigranular to porphyritic). Foliation is variably developed and generally parallels the margins of the unit which conform to regional trends. The complex includes abundant amphibolitic screens and a variety of dyke rocks: diorite, granodiorite, biotite granite (Cape Smoky pluton) and diabase.

The Ingonish River pluton is a large body of medium- to coarse-grained tonalite. Amphibole content varies so that in places the rock appears more leucocratic than in others, but potassium feldspar is everywhere absent. Foliation is well developed (although difficult to see in some coarse grained or leucocratic variants) and generally trends north-south to northeast-southwest, parallel to the margins of the body and regional trends. Intensive development of hematite, chlorite and clays occurs locally in association with shear and/or thrust zones.

The four relatively small bodies referred to informally as the Southern granodiorite, Cape Smoky quartz monzonite, Ski Hill granodiorite and Middle Head leucodiorite are all intruded by the Cape Smoky biotite granite or by dykes from that pluton. The Ski Hill granodiorite intruded the Ingonish River tonalite, and on this basis intrusion of the entire group is placed between the tonalite and the biotite granite. The Middle Head body is primarily leucodiorite, containing no potassium feldspar, and has intruded dioritic rocks which are probably equivalent to parts of the dioritic complex to the south.

The distinctive Cape Smoky biotite granite is typically pink to red, coarse grained, and locally foliated. It is gradational to leucogranite. The petrology was described by Barr et al. (1982). Red granite dykes obviously related to this intrusion are abundant in the other granitoid units, especially the dioritic complex, and an extensive apparently continuous body of red biotite granite separates the Ingonish River tonalite from the micaceous diorite to the west. Numerous mafic dykes occur in all of these intrusions.

The southern limits of these Siluro-Ordovician and older granitoid units have not yet been defined by mapping (Fig. 1). However, to the north they are cut off by the large Cameron Brook pluton, composed of distinctive coarse grained red megacrystic granite. Megacrysts are composed of microcline. The rock is similar to megacrystic granites of Devonian age (Jamieson and Craw, 1983) in the western Cape Breton Highlands, and therefore is also considered to be Devonian.

SUMMARY

Mapping during 1983 has defined the distribution of major metamorphic and intrusive rock units in the Ingonish River-Wreck Cove area of the Cape Breton Highlands, and confirmed a complex deformational, metamorphic and intrusive history. Correlations outside of the map area are tentative, and few ages of the plutonic rocks are known. The 447 ± 37 Ma date derived from the Cape Smoky pluton (Cormier, 1980) is significant because, if correct, it indicates that much of the plutonic, and therefore the deformational and metamorphic, activity predates the Siluro-Ordovician boundary. The Cape Breton Highlands therefore display effects of Taconic and/or Late Hadrynian (Cadomian) deformational events, as well as the Acadian Orogeny.

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GEOLOGY OF THE SOUTHERN ANTIGONISH HIGHLANDS, NOVA SCOTIA*

J. B. Murphy**

ABSTRACT

Continuation of mapping in the southern Antigonish Highlands has considerably altered the interpretation of the geological history of the region. Principally, the Keppoch Formation, a sequence dominatd by felsic to mafic volcanic rocks and previously thought to be of Cambrian age, is now assigned to the Precambrian. The Keppoch Formation unconformably underlies the James River Formation of the Precambrian Georgeville Group, a sequence dominated by oceanic-type volcanic and sedimentary rocks. The relations of the Keppoch Formation to older formations of the Georgeville Group are unknown and await further mapping.

Within the Antigonish Highlands, rocks formed in an oceanic region to the north (Georgeville Group) adjoin rocks formed in a continental region to the south (Keppoch Formation). The junction between these two zones may be close to the Browns Mountain or Marshy Hope faults.

Lower Paleozoic rocks generally flank the Highlands and within the Highlands adjacent to major faults.

INTRODUCTION

Geological mapping in the Antigonish Highlands during 1983 continued a project, initiated in 1978 by the Nova Scotia Department of Mines and Energy in co-operation with the Canada Department of Regional Economic Expansion, that concentrated on the northern Antigonish Highlands. The purpose of the present study is to map the adjoining northwestern and southern Highlands, to describe the volcanic, sedimentary and plutonic rocks and their stratigraphic and structural relations, to determine their geological history and to examine the potential for mineralization. The Antigonish Highlands comprise about 1500 km^2. To date 650 km^2 have been mapped, 300 km^2 in 1978 and 1979 in collaboration with J. D. Keppie of Nova Scotia Department of Mines and Energy and A. J. Hynes of McGill University, and a further 350 km^2 during 1983.

Stratigraphic and structural relationships described below, when augmented by previous work (Murphy et al., 1982 and in preparation), allow a more comprehensive view of the geological history and tectonic setting of the Highlands. Mineral occurrences observed so far are of rather limited economic interest (Bourque, 1981); interpretation as to the economic

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*Also in Current Research, Part A, Geological Survey of Canada, Paper 84-1A, p. 587-595, 1984. (with abstract in French).
Contribution to Canada-Nova Scotia Co-operative Mineral Program 1981-84. Project carried by Geological Survey of Canada.

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potential has been hindered by lack of stratigraphic control. This report documents interesting new mineral occurrences and provides the stratigraphic and structural field relationships within which they may be investigated.

GEOLOGICAL SETTING

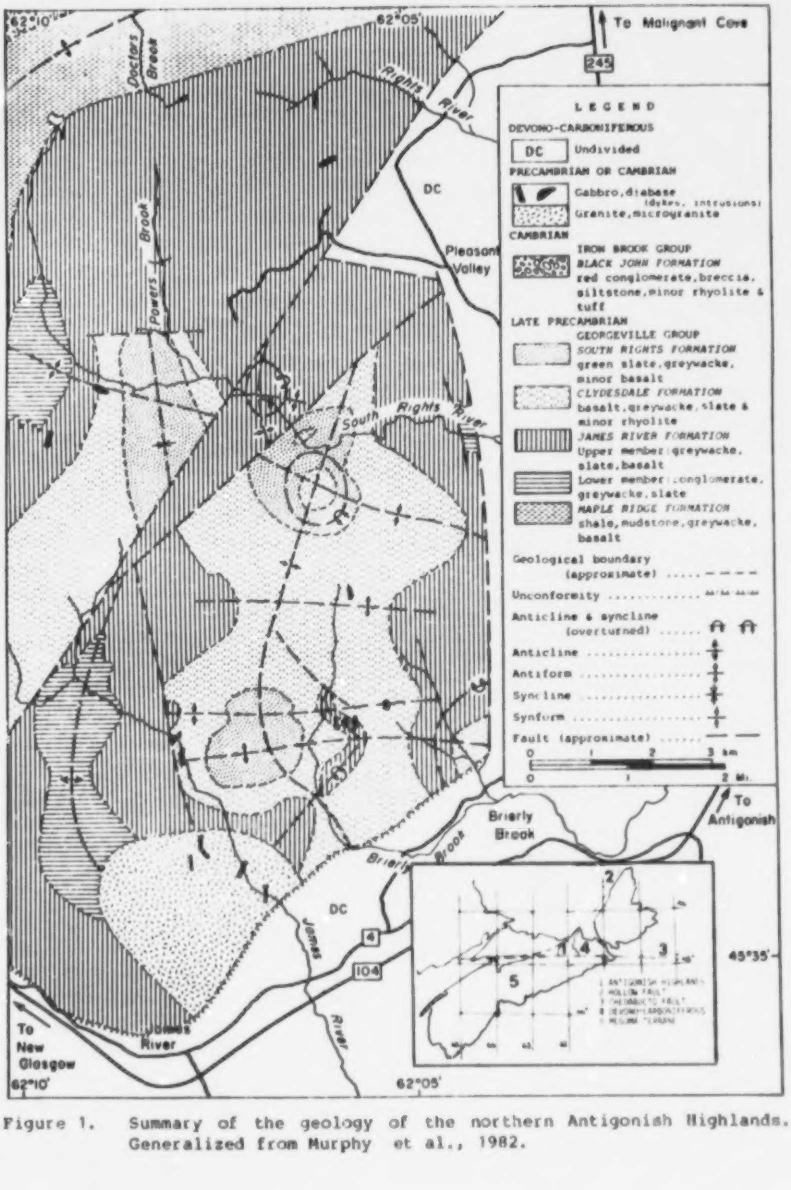
Rocks of the Antigonish Highlands form part of the Avalon "Composite" Terrane (Keppie, 1983) or "Suspect" Terrane (Williams and Hatcher, 1982) and lie on the southeastern margin of the northern Appalachians. The rocks are bounded to the northwest by the Hollow Fault, to the south by the Chedabucto Fault and to the east by the Devonian-Carboniferous Antigonish Basin (Fig. 1). They consist predominantly of Precambrian metavolcanics and metasediments, unconformably overlain by lower Paleozoic strata. In general, most late Precambrian "subterranes" within the Avalon Terrane are characterized by mafic to felsic volcanic rocks with minor associated volcanogenic sediments (see Rast et al., 1976). Parts of this terrane consist of the Jeffers and Warwick Mountain formations in the Cobequid Highlands (Donohoe and Wallace, 1980) and the Fourchu Group in southeastern Cape Breton Island (Murphy, 1977).

PREVIOUS WORK

Benson (1974) interpreted the rocks of the Highlands as "a folded and faulted pre-Silurian eugeosynclinal assemblage of probable Cambro-Ordovician age, overlain by less disturbed Siluro-Devonian sedimentary and volcanic rock". Reconnaissance work by Keppie (1978) followed by detailed mapping by Murphy et al. (1982) indicated that most rocks of the Antigonish Highlands are of Precambrian age and are unconformably overlain by Cambrian strata. Interpretations of geochronological studies (Cormier, 1979; R. F. Cormier, personal communication, 1980; R. K. Wanless, written communication, 1980) and paleontological studies (Landing et al., 1980) have substantiated these interpretations.

As a result, the term Browns Mountain Group (Benson, 1974), to which these rocks were previously assigned, has been abandoned and replaced by three new groups: the Georgeville Group of Precambrian age and the Iron Brook and the MacDonald Brook groups of Cambrian age. The study showed that Precambrian and Cambrian rocks have distinctly different sedimentary and structural histories, and that their geochemistry indicated they were formed in different paleogeographic and tectonic settings.

The Georgeville Group in the northern Highlands was interpreted to represent a narrow deep-water basinal sequence, probably floored by oceanic crust. The group is dominated by plane, finely laminated mudstones, greywackes, matrix-supported conglomerates, interlayered basalts and associated dykes with minor cherts and limestones. These rocks were polydeformed and posttectonically intruded by granite (alaskite) and gabbro (appinite) in the latest Precambrian. Cambrian rocks were interpreted as a rift-related succession. The Iron Brook Group consists of fluviatile to shallow-water marine, fossiliferous sediments (red conglomerates and slates, pink limestones, ironstones, and calcareous tuffs). The MacDonald Brook Group consists of red conglomerates, mafic and felsic volcanic rocks with minor interlayered red slates and pink limestones.


62°10'
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To Malignant Cove
245
Doctors Brook
Rights River
Powers Brook
DC
Pleasant Valley
South Rights River
LEGEND
DEVONO-CARBONIFEROUS
DC Undivided
PRECAMBRIAN OR CAMBRIAN
Gabbro, diabase (dykes, intrusions)
Granite, microgranite
CAMBRIAN
IRON BROOK GROUP
BLACK JOHN FORMATION
red conglomerate, breccia, siltstone, minor rhyolite & tuff
LATE PRECAMBRIAN
GEORGEVILLE GROUP
SOUTH RIGHTS FORMATION
green slate, greywacke, minor basalt
CLYDESDALE FORMATION
basalt, greywacke, slate & minor rhyolite
JAMES RIVER FORMATION
Upper member: greywacke, slate, basalt
Lower member: conglomerate, greywacke, slate
MAPLE RIDGE FORMATION
shale, mudstone, greywacke, basalt
Geological boundary (approximate)
Unconformity
Anticline & syncline (overturned)
Anticline
Antiform
Syncline
Synform
Fault (approximate)
0 1 2 3 km
0 1 2 Mi.
To Antigonish
Brierly Brook
Brierly Brook
DC
James River
4
104
To New Glasgow
James River
River
2
1
4
3
5
45°35'
62°10'
62°05'

Figure 1. Summary of the geology of the northern Antigonish Highlands. Generalized from Murphy et al., 1982.

Upper Ordovician and Lower Silurian rocks have been described in the Kenzieville area of the Highlands by Maehl (1961) and Smith (1979). The regional extent of these rocks and their tectonic significance are unknown though Smith (1979) suggested that they may be correlatives of the rift-related (Keppie et al., 1978) Dunn Point Formation exposed at Arisaig to the north of the Hollow Fault.

RESULTS OF PRESENT STUDY

The principal results of the field work during 1983 may be summarized as follows:

1. The Keppoch Formation, considered by Benson (1974) to comprise the lowermost formation of his Cambro-Ordovician "Browns Mountain" sequence, is Precambrian in age.

2. The Keppoch Formation is informally subdivided into members dominated by felsic, intermediate, and mafic volcanic rocks and sediments.

3. Sediments are uncommon in the Keppoch Formation whereas sediments are overwhelmingly dominant in the Georgeville Group.

4. Field relationships indicate that the dominantly volcanic Keppoch Formation is in part a facies variation of the dominantly sedimentary Georgeville Group.

5. The economic potential of the Keppoch Formation, especially members with abundant felsic volcanics, is particularly encouraging. Some interesting, apparently stratabound pyritic zones were found. Some of these extend discontinuously for about 2 km.

6. Rocks in the northwestern Highlands are an extension of those in the northern Highlands and the stratigraphic units and structural trends continue from one area into the other.

7. The Browns Mountain Fault and the Marshy Hope Fault may approximate the boundary between rocks in the northern Antigonish Highlands deposited upon oceanic crust and rocks in the southern Highlands deposited upon continental crust.

8. Upper Ordovician and Silurian rocks are far more widespread than previously believed. Remnants occur here and there, either flanking the Highlands or in fault-bounded belts. The stratigraphy of these rocks within the Highlands is little known. They consist of red fluviatile arkosic conglomerates, red slates, felsic volcanics and blue-green fossiliferous siltstones. The stratigraphy is similar to that on the northern side of the Hollow Fault, and the sequence represents the oldest rocks that occur on both sides of the Hollow Fault.

9. Plutonic rocks in the present field area may be divided into three categories on the basis of field observations incorporated with geochronological data supplied by Cormier (1979) and Wanless et al. (1967). Appinitic gabbros and granites are probably late Precambrian in age. Some granites are of Devonian age. Other granites of late Precambrian age may be cogenetic with felsic volcanic rocks of the Keppoch Formation.

10. Dykes are generally mafic in composition and probably of several ages. Mafic dykes cut late Precambrian, lower Cambrian, lower Ordovician, Silurian and Devono-Carboniferous rocks. Distinguishing between these dykes is difficult in the field and requires detailed geochemistry.

PRECAMBRIAN

LITHOLOGY

The northwestern Highlands are dominated by the Maple Ridge and James River formations (Fig. 2). Both formations display similar characteristics to their type areas to the east and have been described in detail by Murphy et al. (in preparation). The Maple Ridge Formation is well exposed in the Vamey Lake and Eigg Mountain areas. It consists of thinly (2-15 mm) plane laminated, poorly cleaved green and black mudstones with relatively subordinate interlayered green graded greywackes. Minor mafic flows may occur. The mudstones show graded bedding, crossbedding and slump structures.

The James River Formation conformably overlies the Maple Ridge Formation and consists of about 1000 m of greywackes. In the northwest, individual units are typically 2-3 m thick (Vamey River in the vicinity of the Hollow Fault) and farther south 1 m thick (east of Bears Brook). Greywacke units grade from a coarse clastic base with load features to a slaty top that may display crossbedding.

The northern section of the Antigonish Highlands is separated from the southern section by the Marshy Hope Fault (which trends subparallel to the Trans-Canada Highway) and by a sequence of Upper Ordovician to Silurian rocks near the fault. Rocks of the Georgeville Group in this section are correlated with the northern section on the basis of lithologic comparison. Greywackes and slates typical of the James River Formation occur adjacent to the contact with the Keppoch Formation.

The South Rights Formation outcrops to the south of the Trans-Canada Highway (e.g. Baxter Brook) and consists predominantly of green, thinly laminated slates and minor greywackes. In many ways, these rocks are similar to the Maple Ridge Formation and can only be distinguished with confidence on the basis of stratigraphic relationship with the James River Formation.

The Keppoch Formation consists predominantly of volcanic rocks ranging from rhyolite to basalt with very minor interflow sediments. The best exposures occur in the Mayfield area, on Frasers and MacIsaac brooks (Fig. 2), on the northern tributary of Beaver Brook and on new logging

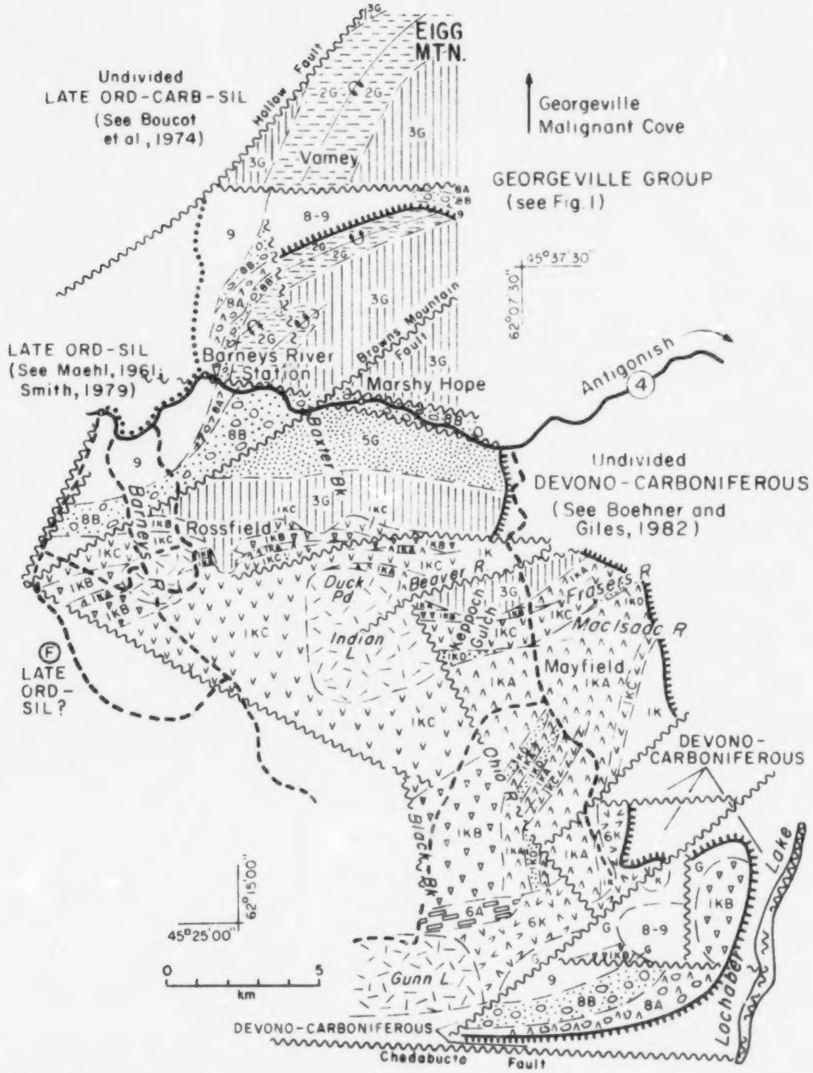

EIGG MTN.
Undivided
LATE ORD-CARB-SIL
(See Boucot et al, 1974)
Hollow Fault
Georgeville
Malignant Cove
Varney
GEORGEVILLE GROUP
(see Fig. 1)
2G
3G
8-9
9
8A
8B
45°37'30"
62°07'30"
Browns Mountain Fault
LATE ORD-SIL
(See Maehl, 1961; Smith, 1979)
Barneys River Station
Marshy Hope
Antigonish
4
Baxter Bk
5G
Undivided
DEVONO-CARBONIFEROUS
(See Boehner and Giles, 1982)
Barneys R
Rossfield
IKC
IKB
IKA
IK
IKD
Duck Pd
Beaver R
Kenloch Gulch
Frasers R
MacIsaac R
Indian L
Mayfield
F
LATE ORD-SIL?
DEVONO-CARBONIFEROUS
Ohio Bk
Black Bk
6K
6A
G
45°25'00"
62°15'00"
0
5
km
Gunn L
Lochaber Lake
DEVONO-CARBONIFEROUS
Chedabucto Fault

Figure 2. Summary of the geology of the central Antigonish Highlands. References are given for available geological maps in adjoining areas. The map is the western and southern extension of the geology shown in Figure 1.

LITHOLOGY*

DEVONIAN

▨ Granite (quartz, microline, plagioclase, muscovite, biotite, hornblende), minor assimilated host rock.

LATE ORDOVICIAN
-SILURIAN

9 *BEECHHILL COVE FORMATION* (blue green fossiliferous siltstone)

8A 8B *BEARS BROOK FORMATION* (8A, rhyolite flow and tuff; 8B, red conglomerate, arkose and slate)
See Maehl (1961) and Smith (1979).

CAMBRIAN-
EARLY ORDOVICIAN

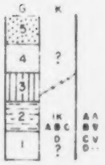
7A 7B 7A, MACDONALD BROOK GROUP* (red conglomerate, slate, basalt, ryholite)
7B, IRON BROOK GROUP* (red conglomerate, slate, limestone, ironstone, tuff).
See Murphy et al. (1982).

LATE PRECAMBRIAN
or CAMBRIAN

6K Granite, quartz-feldspar graphic intergrowth.

PRECAMBRIAN

6A Appinite, hornblende-plagioclase porphyritic and poikilitic gabbro or diorite.



G GEORGEVILLE GROUP (see Fig. 1
Formations, 1G CHISHOLM BROOK*, 2G *MAPLE RIDGE*, 3G *James River*, 4G CLYDESDALE*, 5G *South Rights*).

K *KEPPOCH FORMATION* (1K undivided, 1KA felsic member, 1KB intermediate member, 1KC mafic member, 1KD sedimentary member).

NOTE:* indicates that the unit is not exposed in the present study area.

Geological boundary	— — —
Limit of mapping	....
F_1 hinge surface trace	—∩—
Fault	∿∿∿∿
Unconformity	┴┴┴┴┴┴
Fossil locality (new)	Ⓕ
Highway, secondary route	—— - - -

roads about 1 km east of this tributary. In any given section all of the above lithologies occur interlayered.

Felsic rocks consist of flows, welded to poorly welded ash flow tuffs (ignimbrites), crystal and lithic tuffs, lahars and volcanic breccias. In the field, the rocks are generally pink to dark red and apparently massive. However, the ignimbrites generally display banding defining a primary flattening foliation that is commonly parallel to the regional strike and is assumed to approximate bedding.

True rhyolitic flows are rare in the Keppoch Formation; probably 80 per cent of exposed rocks are pyroclastic. In thin section, flows are aphyric, display crude flow alignment and consist of interlocking grains of plagioclase (now albite), orthoclase, quartz and devitrified glass. Alteration of felsic flows is minor with epidote, chlorite ± calcite occurring as rare secondary phases. Ignimbrites probably account for one-third of the felsic volcanics. The banding visible in hand specimen is defined in thin section by devitrified and partially sericitized pumice imparting a eutaxitic primary foliation. Pumice is also moulded against other fragments, their boundaries are wispy and merge imperceptibly into the felsic matrix. Flattened rhyolitic fragments up to 40 mm long are common in the ignimbrites, as are angular, broken and embayed crystals of quartz, orthoclase and plagioclase (now albite). Much of the brecciation is "in situ". Alteration of ignimbrites is generally minor and consists of small clots rich in chlorite and epidote.

Lithic and crystal tuffs are relatively fine grained and their tuffaceous aspect is commonly not readily visible in the field. They generally consist of variable proportions of angular, moderately well-sorted fragments of felsic volcanics (which themselves commonly display flow textures), quartz (generally embayed), orthoclase (incipiently sericitized) and plagioclase (now albite) in a fine grained quartzo-feldspathic matrix. Alteration is minor.

Lahars in hand specimen are reddish green and contain poorly sorted, matrix-supported angular fragments of felsic volcanics, quartz and feldspar with minor intermediate to mafic clasts. Best exposures are along the northern branch of Beaver River, south of the "Duck Pond". In thin section, the matrix is very fine grained and consists of variable proportions of sericite, chlorite, and quartz ± epidote. Sericite-rich lahars generally have a well-defined foliation. Felsic volcanic fragments are generally tuffaceous. Feldspar fragments are commonly strongly sericitized.

Andesites are green to pale green massive rocks, generally containing plagioclase phenocrysts up to 10 mm long. Best exposures are near Rossfield (adjacent to the microwave tower), Beaver River area and west of Lochaber Lake. In thin section, andesites display secondary alteration to varying degrees, but primary textures are preserved. They are dominated by flow-aligned phenocrysts and microphenocrysts of plagioclase (now albite) and augite (partly to completely pseudomorphed by chlorite and/or actinolite). The matrix consists of variable proportions of albite, magnetite, epidote, quartz, chlorite and sphene ± calcite.

Basalts are dark green, chloritic, massive aphyric rocks. More rarely, they contain vesicles, quartz-chlorite filled amygdules, and/or chlorite pseudomorphs of pyroxene phenocrysts. In thin section, the rocks are relatively fresh, consisting of rare but fresh microphenocrysts of augite ± hypersthene. The matrix consists of equant grains of augite and hypersthene, plagioclase laths (now albite) and magnetite-ilmenite intergrowths. Pyroxenes show incipient alteration to chlorite ± actinolite.

Pyritic zones are most commonly found in felsic volcanics. They contain variable amounts of pyrite with traces of copper minerals. Occurrences are generally small and there is one promising occurrence near Callahans Brook. The pyritic zones are apparently stratabound within a rhyolitic tuffaceous volcanic member, 250 m thick and interlayered with mafic volcanics. The mafic volcanics show variable degrees of silicification near their contacts with the rhyolitic tuff.

CONTACT RELATIONS

Precambrian rocks in the map area have been subdivided into two main categories. Sediments are dominant to the north (Maple Ridge, James River and South Rights formations) and volcanic rocks to the south (Keppoch Formation). In the northern region, the Maple Ridge and James River formations can be traced from the eastern Highlands (Murphy et al., 1982) southwards to the Marshy Hope Fault. The contact between these two formations is apparently everywhere conformable and sharply defined by the relative dominance of shales (Maple Ridge) and greywackes (James River).

The Marshy Hope Fault and associated Upper Ordovician and Silurian rocks separate Precambrian exposures to the north and the south. Correlations between northern and southern sequences are based on lithologic comparison and overall stratigraphic considerations of the northern areas. An east-striking formation consisting of greywackes with slaty tops, minor interbedded, matrix-supported conglomerates and volcanic rocks is typical of the James River Formation. These rocks are best exposed in the Keppoch Gulch and Camerons River areas. They consistently face north and are conformably overlain by a sequence of thinly laminated mudstones with minor greywackes (e.g. Baxters Brook). These rocks are correlated with the South Rights Formation of the northern Highlands (see Murphy et al., 1982, Fig. 1). The Clydesdale Formation (which in the northern Highlands is stratigraphically defined between the James River and South Rights formations and is characterized by a dominance of basaltic volcanics) apparently does not occur in the southern Highlands. In detail, the Clydesdale Formation consists of an ocean island "complex" (Murphy et al., in preparation) of lavas, dykes and sills associated with a strong, linear, positive, vertical-gradient magnetic anomaly (Geological Survey of Canada, 1982) and is thus likely to be of limited lateral extent.

The contact between the Georgeville Group and the Keppoch Formation is exposed on the Mayfield road. There, slates and greywackes of the James River Formation stratigraphically overlie quartz-eyed rhyolites of the Keppoch Formation. Bedding in the sediments is concordant with the contact; no banding was found in the rhyolites. On a regional scale however, the contact is discordant. Between the road section and the Keppoch Gulch River section to the west (where the river valley separates sediments from volcanc rocks, Fig. 2) the James River Formation unconformably overlies the rhyolites to rest upon a predominantly mafic to intermediate volcanic sequence. A screen-type deposit of basal James River in Keppoch Gulch consisting of angular volcanic clasts in a sedimentary matrix occurs at the contact. Furthermore, facing directions obtained in volcanic rocks near this contact consistently face south, in contrast to the north-facing stratigraphically overlying James River sediments. The above relationships indicate that the Keppoch Formation predates the James River Formation of the Georgeville Group. Further mapping is required to document the relations between the Keppoch Formation and the older formations of the Georgeville Group. However, since the entire Georgeville Group, on the basis of stratigraphic, structural, geochemical, and geochronological arguments, has been interpreted to be of Precambrian age (Keppie, 1978; Murphy et al., in preparation), the Keppoch Formation may now be assigned a Precambrian, probable Hadrynian, age. With the extent of present mapping, it is not possible to establish whether or not the regional unconformity is due to earlier deformation of the Keppoch Formation. Although the Keppoch does have different structural style and trends compared to the Georgeville Group, this could equally be due to primary distribution of the Keppoch and/or to competency differences between the sedimentary and volcanic sequences.

Geochronological data support a Precambrian age for the Keppoch Formation. From reconnaissance work, the Eden Lake "appinitic" pluton (3 km to the west of the map area) apparently intruded the Keppoch Formation (see also Benson, 1974) and has been dated at 582 ± 32 Ma (Wanless et al., 1967, K/Ar on hornblende), and thus places a minimum age for the Keppoch Formation. Similar appinites have been found in the Black Brook region in the southwest of the study area and the Greendale Complex to the northeast of the map area dated at 632 ± 10 Ma by P. H. Reynolds (personal communication, 1980, $^{40}Ar/^{39}Ar$ on hornblende).

Zircons for U/Pb age determinations have been collected by W. H. Poole from the felsic rocks of the Keppoch Formation, and the results of this analysis may have significant implications for the geological history of the Highlands rocks.

Further distinction between the Keppoch Formation and Georgeville Group may be gained by comparing their respective environments of deposition. Whereas the stratigraphy of the Georgeville Group (i.e. ocean floor basalts with plane laminated mudstones and greywackes) suggests a basinal environment, welding of ignimbrites and weathered tops to flow units indicates a subaerial environment in the Keppoch Formation. Coarser units of the Georgeville Group contain abundant volcanic clasts of basaltic to rhyolitic composition which may, in part, be derived from the Keppoch. Thus the contact between deep water sediments and subaerial volcanic rocks with no "intermediate" facies suggests that much of the Keppoch volcanic rocks were submerged during James River sedimentation which may have "draped" the Keppoch. This is supported by the apparent restriction of Georgeville-type sediments to the flanks of the Keppoch Formation (Fig. 2), and may imply a significant time-gap between Keppoch and James River formations.

However, stratigraphic relations also indicate that minor "late Keppoch-type" volcanism may have occurred during deposition of the James River Formation. Minor mafic and felsic volcanics do occur near the base of the formation. Although the mafic volcanic rocks could also be attributed to distal precursors of Clydesdale ocean island volcanism, felsic volcanics, however minor, are in general atypical of Georgeville Group-type volcanics and may represent late-stage distal Keppoch-type activity. This felsic volcanic unit (a distinctive quartz-eyed porphyry) may be a useful marker horizon within the James River Formation. The above relations cannot be attributed to **local** interlayering of volcanic and sedimentary rocks (i.e. a transitional Keppoch-James River contact) since (1) these formations have apparently opposing facing directions in the vicinity of the contact, and (2) it is unlikely that subaerial volcanics and deep water sedimentary rocks would be deposited directly next to one another. Thus, the felsic unit, if related to Keppoch-type volcanism, is considerably younger than Keppoch volcanic rocks adjacent to the Keppoch-James River contact and may indicate that felsic volcanism overlaps in time the deposition of the James River Formation.

Volcanic rocks of the Kepoch Formation have been divided into informal members on the basis of dominance of felsic, intermediate, mafic, and sedimentary rocks (Fig. 2). These boundaries either overlap or cut across Benson's (1974) assumed contact between his predominantly felsic Keppoch Formation and his mafic Brierly Brook Formation. The Brierly Brook Formation has been discarded (Murphy et al., 1982) since the mafic rocks they include probably belong to three separate formations, two Precambrian (Chisholm Brook and Clydesdale) and one Cambrian (Arbuckle Brook).

The contacts between members of the Keppoch Formation are defined on a percentage scale though, in a given locality basalt, andesite, and rhyolite may be interlayered. Formal subdivision is not warranted with present data since facing directions are rare. Thus it is not possible at present to evaluate whether, for example, all mafic-dominated volcanic members are part of one stratigraphically continuous unit or whether interlayering of volcanic rocks occurs on a regional scale. This may be resolved by detailed mapping in the vicinity of these contacts.

UPPER ORDOVICIAN AND SILURIAN

LITHOLOGY

Upper Ordovician and Silurian rocks that unconformably overlie Precambrian strata in the Antigonish Highlands have been defined as the Bears Brook Formation (Maehl, 1961; Smith, 1979) from the type area north of Bears Brook in the Kenzieville and Barneys river areas. They consist of red conglomerates, arkosic sandstones, felsic crystal and lithic tuffs and minor red slates conformably or disconformably overlain by the fossiliferous lower Silurian Beechhill Cove Formation.

The present study shows they are far more widespread than previously recognized (Fig. 2) and that their stratigraphy throughout the Highlands is generally consistent with that determined by the above authors (e.g. in the South Lochaber and College Grant areas).

The conglomerates and arkoses are polymictic and massive, containing subangular to angular clasts of red and green slate, felsic to mafic volcanic rocks, granite, quartz, albitized plagioclase, sericitized K-feldspar, pyrite and hematite. Many of the grains are coated with hematite. The matrix also contains chlorite, sericite and epidote. The best exposures are on the Trans-Canada Highway near Marshy Hope, on McIver Brook (Smith, 1979), and on South Lochaber.

Felsic volcanic rocks are interlayered with, or conformably overlie, the conglomerates and arkoses. They are massive, purple to pale grey rocks composed of lithic and crystal fragments in a fine grained matrix. They are, in part, apparently intrusive (Smith, 1979), but some rocks contain pumice and glass shards and are probably ignimbrites, and others show evidence of flow banding. Crystal and lithic tuffs are generally composed of broken phenocrysts of plagioclase (now albite), sericitized orthoclase, and quartz, with variable abundances of rhyolitic fragments in an ash-sized matrix.

Pumice and glass shards in ignimbrites show evidence of primary flattening imparting a nonpenetrative primary foliation. For the present, rhyolitic rocks are undivided, though future mapping may result in the recognition of a systematic distribution of various felsic lithologies.

Rhyolites are overlain, apparently concordantly, by either red conglomerates and arkoses similar to those described above, or by laminated, fossiliferous, blue-green siltstones and slates. In the northern Highlands these siltstones have been placed in the Beechhill Cove Formation (Maehl, 1961; Smith, 1979; Murphy et al., 1982). These rocks are now identified in various parts of the southern and western Highlands (Fig. 2). They contain brachiopods, corals, crinoids, and trilobites (Smith, 1979). The Beechhill Cove Formation is thought to define the base of the Silurian (e.g. Boucot et al., 1974) thereby establishing a minimum age for the Bears Brook Formation.

DISTRIBUTION

Upper Ordovician and Silurian rocks are generally spatially associated with major faults in the area. Thus they occur at the extremities of the Highlands (Fig. 2) and also internally in narrow fault-bounded "troughs", e.g. the Hartshorn River adjacent to the Marshy Hope Fault.

INTRUSIVE ROCKS

Plutonic rocks are rare in the northern Antigonish Highlands, especially between the Browns Mountain and Hollow faults. However, in the southern Highlands they may be divided into three categories, (a) appinite, (b) older granites, and (c) younger granites, on the basis of lithology, intrusive relations and available geochronological data.

(a) Appinites (i.e. hornblende-bearing gabbros) occur in the Black Brook region in the south of the study area. They consist of roughly equal proportions of hornblende and plagioclase. They are generally fine grained and equigranular, but coarse hornblende-plagioclase pegmatites and quartzofeldspathic sweat pods also occur. Although no contacts are exposed, the appinite apparently intruded the Keppoch Formation near Black Brook and is in turn intruded by younger granites to the south (Fig. 2). They strongly resemble the igenous rocks of the Greendale Complex dated at 632 ± 10 Ma (P. H. Reynolds, personal communication, 1980, $^{40}Ar/^{39}Ar$ on hornblende). The intrusive body at Eden Lake to the west has yielded a 582 ± 32 Ma age (Wanless et al., 1967, K/Ar on hornblende). Thus geochronological data suggests a late Precambrian "appinitic" intrusive event in the Antigonish Highlands.

The older granites pose a problem and in the map area, the best example occurs on the Ohio River. They consist of quartz and sericitized K-feldspar in graphic intergrowth, plagioclase and minor biotite (altered to chlorite). They are similar in texture and mineralogy to the Williams Point Granite east of Antigonish (Dobek, 1983) and to the James River pluton about 1 km east of the map area. However, some contain aplitic or rhyolitic phases, and are commonly difficult to distinguish from spatially associated rhyolitic volcanic rocks of the Keppoch Formation. Contacts with the Keppoch Formation are not exposed, but the spatial distribution suggests the contact may be both gradational and transitional. On the basis of these field relations, the older intrusives are tentatively interpreted to represent subvolcanic stocks related to Keppoch volcanism. Further evaluation of this interpretation awaits geochemical and geochronological data. Radiometric data available at present yeild an age of 533 ± 19 Ma for the Ohio stock (Cormier, 1979). Similar age determinations have been obtained from the James River and Williams Point granites (Rb/Sr whole-rock isochrons, R. F. Cormier, personal communication, 1983) and apparently represent a comagmatic suite.

Younger "two-mica" granites intruded all rocks in the map area including the lower Silurian Beechill Cove Formation (Fig. 2). They occur at Barneys River, Gunn Lake and Indian Lake. They consist of equigranular, coarse grained, anhedral, interlocking crystals of quartz, microcline, plagioclase, biotite and muscovite. They are generally unaltered. The Barneys River pluton shows evidence of widespread assimilation and magmatic stoping of country rock (mafic volcanic rocks of the Keppoch Formation). The Barneys River and Gunn Lake plutons have been dated at 378 ± 12 Ma and 370 ± 15 Ma respectively (Cormier, 1979).

HISTORY OF DEFORMATION

For the purposes of this discussion, the Precambrian structure of the Highlands may be divided into three regions:

Region 1. north of the Browns Mountain Fault (BMF)

Region 2. between the Browns Mountain Fault and
the contact with the Keppoch Formation.

Region 3. the Keppoch Formation.

Structural styles and deformational history vary considerably from north to south of the mapped area. In general, there are two main factors involved: firstly, the decreasing intensity of F_1 deformation in region 2 relative to region 1 and secondly, the volcanic rocks of the Keppoch Formation display a different structual style relative to the sediments of the Georgeville Group. Although orientations of fold structures appear to have been affected by major faults in the region, fold styles appear to be relatively consistent within each region.

Region 1: North of Browns Mountain Fault the outcrop pattern is dominated by a northeasterly trending F_1 anticlinal fold. The Maple Ridge Formation, in the core of the fold, is flanked by the James River Formation to the northwest and southeast. The structure is the continuation of the F_1 fold mapped to the east (compare Murphy et al., 1982, Fig. 1). The fold style is isoclinal as evidenced by comparison with minor F_1 folds, and by S_0 (bedding)/S_1 (penetrative cleavage) parallelism on limbs. The locus of the hinge surface trace is defined by localities of high S_0/S_1 angular relations (e.g. east of Vamey River, Fig. 2). Cleavage in the hinge zone is typically more strongly developed, generally making bedding less visible than on the limbs. The orientation of the axial plane adjacent to the Hollow Fault is steep to vertical and the fold axis plunges gently to the northeast. This orientation may have been affected by movement along the adjacent northeasterly trending fault. To the west, as the axial trace moves away from the Hollow Fault, the fold axis steepens though it is still northeasterly trending (observe S_0/S_1 relations, Fig. 2). The F_1 structure is truncated to the south by the Vamey Fault, and extrapolation is obscured by uncomformably overlying Silurian strata. However, a major anticlinal structure is interpreted in the Bears Brook area, where opposing facing directions on a regional scale occur in monoclinal successions.

F_2 northeast- to north-trending upright folds are common in the northeastern Highlands (Murphy et al., in preparation), but regional F_2 hinge zones have not been identified with certainty in region 1, although one F_2 fold hinge has been tentatively interpreted there (Fig. 2). Where they occur in the eastern Highlands, their axial traces generally parallel those of F_1, but they may be distinguished from them in that they fold both S_0 (bedding) and S_1 (penetrative cleavage). The lack of F_2 fold closures may reflect an east to west structural inhomogeneity in the northern Highlands, or more probably, that the present study area is located on one limb of a major F_2 fold.

F_3 folds in the northeastern Highlands are considered to be responsible for the overall change in orientation of F_1 and F_2 folds from northeast trending in the extreme north of the area to north trending farther south. Regional F_3 folds in region 1 are common (Fig. 2) though minor congruous folds are rare. Folds are generally upright, moderately westerly plunging with broad hinge zones. A weak axial planar fracture cleavage is generally developed. Rarely, S_0/S_3 intersections may also plunge easterly; the change in the sense of plunge may reflect F_3 superposition on opposing limbs of F_2 folds, and may help define F_2 structures.

Region 2: In contrast to generally north structural trends to the north of the Browns Mountain Fault, the area south of the fault is dominated by an east striking monoclinal succession generally dipping and facing to the north. Minor modifications are due to upright folds and/or local faults. Although S_0/S_1 parallelism does occur in this zone, it is by no means the rule as in region 1, and S_0/S_1 intersections commonly occur away from obvious F_1 hinge zones. This relation suggests that the intensity of F_1 folds dies out southwards towards the contact with the Keppoch Formation.

The effects of F_2 and F_3 appear to be minor in region 2. Fracture cleavages associated with these folds are rare, and the sequence is consistently north facing.

Region 3: Deformation in the Keppoch Formation is difficult to evaluate owing to probable primary distribution of rock units, lack of way-up criteria and penetrative foliation, faults, etc. There is evidence from the map pattern that the competent Keppoch Formation may have controlled structural trends in younger rocks. Trends in the Keppoch Formation are generally east on the north and south of the area and north in the eastern parts of the area (Fig. 2). Strikes in younger strata (Precambrian to Carboniferous) generally parallel these trends. This observation generally holds whether the contacts are unconformable or faulted, suggesting that primary distributions of the relatively competent Keppoch volcanic rocks had a significant effect on determining structures. These effects are generally bounded by major faults, whose location is presumably influenced by competence contrast between Keppoch volcanic rocks and adjacent sediments.

The Keppoch Formation is moderately deformed, rarely displays a tectonic fabric and may have behaved in a brittle manner and/or rigid mass during deformation of the Georgeville Group and during subsequent deformations. The map shows that members of the Keppoch Formation can be mapped, but whether their outcrop distribution is governed by primary or deformation considerations awaits further and more detailed analyses.

FAULTING

The Antigonish Highlands are bounded by major transcurrent faults (Fig. 1). The northwestern margin is defined by the northeast trending Hollow Fault, and the eastern margin by the Lochaber Lake Fault. The Hollow and Chedabucto faults are considered to be of major regional tectonic significance and have a long history of repeated movements from Precambrian to post-Carboniferous (e.g. Keppie, 1983). The Highlands are caught "in a vice" between these major lineaments and are consequently disected by many northeast trending faults mainly in the northern Highlands and east trending faults in the southern. Most of these faults have limited displacements, and serve only to complicate mapping and stratigraphic interpretation. However, the following points are of interest:

a. Faults apparently control the distribution of post-Precambrian strata. Upper Ordovician and Silurian rocks are generally exposed in fault-controlled river valleys (e.g. the Marshy Hope Fault - Hartshorn River, on the Trans-Canada Highway). At present it is not possible to determine whether these rocks were deposited in active fault troughs or whether the spatial association is due to post-Silurian downthrow and preservation.

b. Many of the faults that displace the Keppoch Formation can be traced into Devono-Carboniferous rocks to the east (cf. Boehner and Giles, 1982) defining a minimum age for latest displacement.

SUMMARY AND DISCUSSION

Mapping in the Antigonish Highlands has resulted in more detailed information on the geological history of the region. The Precambrian rocks may now be divided into at least two successions that are distinct in lithology, stratigraphy, depositional environment, structural history and probably tectonic setting. The **Georgeville Group** is dominated by intermittent oceanic-type volcanism and a thick basinal-fill sequence of shales and turbidites. The **Keppoch Formation** to the south, in contrast, consists of a volcanic sequence of interlayered rhyolites, andesites, and basalts and minor interflow sediments. The Keppoch Formation predates the James River Formation of the Georgeville Group and is now assigned a Precambrian age. Its temporal relations to older formations of the Georgeville Group are at present unknown and interpretations await further mapping. Geochronological, geochemical and sedimentological data may also furnish insight into the problem. The absolute age of the Keppoch Formation is critical to understanding the tectonic history of the entire Highlands, especially since the Keppoch Formation has now been assigned a Precambrian age. Geochemical data may help to investigate whether minor felsic volcanism in the James River Formation adjacent to the Keppoch Formation is, in fact, a related late-stage (and distal) Keppoch-type magmatism. Comparative geochemistry between Keppoch volcanic rocks and the volcanic rocks of the Georgeville Group may also be instructive especially in view of the fact that the ocean floor basalts of the Chisholm Brook Formation (the oldest formation identified in the Georgeville Group) also displays the geochemical signature of magma mixing (Murphy et al., in preparation). Detailed geochemistry may establish whether the "diluting" agent is a Keppoch component. Conformation or denial would define a significant contribution to the understanding of the Precambrian history of the Highlands.

Although the contact between the James River Formation and Keppoch Formation is exposed, and has been documented above, it is not considered to be the contact between oceanic and continental tectonic domains in the Highlands. It is thought that these James River sediments draped the submerged Keppoch Formation and are themselves probably floored by Keppoch volcanic rocks. The Browns Mountain and/or Marshy Hope faults are thought to be better candidates in this regard, since they define an abrupt change in the style of F_1 folding in the Georgeville Group with the intensity of F_1 folds diminishing rapidly southwards, and they also define a northern limit of felsic plutonism. It is thus likely that rocks south of these faults are presently floored by continental crust, possibly the upper representatives of this crust being an unexposed part of the Keppoch Formation. Such a crust would account for the relatively reduced intensity of deformation of the "draping" sediments of the James River and South Rights formations compared to the F_1 deformation style to the north. A continental basement may have been the source of felsic plutonism. The study may have implications to the geological history of northwestern Cape Breton Island where Precambrian oceanic-type and continental-type rocks are juxtaposed in the vicinity of the Coolavee Fault (Keppie, 1982).

The presence of oceanic- and continental-type domains in the Precambrian sequences may be reflected to a significant degree in the distribution and type of mineral deposits. Mineral occurrences between the Hollow and Browns Mountain faults are rare. However, a felsic volcanic unit in the vicinity of the Browns Mountain Fault is mineralized and was mined for silver at the turn of the centruy. Given the limit of current knowledge, the Keppoch Formation appears to have more potential. Pyritic zones relatd to felsic volcanism may have considerable strike length. The subdivisions of the Keppoch Formation into felsic, intermediate, mafic and sedimentary dominated members, may provide an essential exploration guide in this regard. The study also illustrates that the stratigraphy of the Keppoch is unknown to the west of the mapped area.

ACKNOWLEDGMENTS

I would like to thank J. D. Keppie, Nova Scotia Department of Mines and Energy, for introducing me to the geology of the Antigonish Highlands. I was fortunate to have the excellent field assistance of M. D. Gurney, St. Francis Xavier University. J. D. Keppie, P. S. Giles, Nova Scotia Department of Mines and Energy, and D. G. Benson, Geological Survey of Canada, provided helpful comments in the field. Office facilities during the course of the study were kindly provided by W. S. Shaw, Chairman of the Department of Geology at St. Francis Xavier University, Antigonish. I thank W. H. Poole, J. G. Arnold and B. Manning of the Geological Survey of Canada for organizational support and C. A. Larocque for critically reading the manuscript. Funding for the project was provided by Geological Survey of Canada.

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LATE PALEOZOIC MOTIONS OF THE MEGUMA TERRANE, NOVA SCOTIA: NEW PALEOMAGNETIC EVIDENCE*

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ABSTRACT

Three rock units from southern Nova Scotia were sampled for a paleomagnetic study of the relationship of the Meguma Terrane to the Atlantic-bordering continents during the Paleozoic. These include the Siluro-Ordovician White Rock Formation volcanics, sandstones of the Lower Devonian Torbrook Formation and redbeds of the Lower Carboniferous Cheverie Formation. Progressive thermal and alternating field demagnetization of the White Rock basalts and rhyolites reveal a single component magnetization with a mean direction of $D = 149.1°$, $I = 24.3°$, $\alpha_{95} = 10°$, for $N = 13$ sites. Rotation of the site mean directions about the axis of the Torbrook Syncline suggest a postfolding (post Middle Devonian) age for this magnetization, which corresponds to a pole at 21.9°N Latitude, 147.7°E Longitude after correction for post-Triassic regional tilting. The magnetization of the Torbrook Formation ($D = 15.8°$, $I = 29.6°$, $\alpha_{95} = 11.7°$) is clearly a secondary magnetization whose pole (55.5°N Latitude, 90.7°E Longitude) lies near Triassic poles from both North America and southern Nova Scotia. The age of the Cheverie Formation magnetization ($D = 146°$, $I = 25°$, $\alpha_{95} = 6°$, tilt corrected) appears to predate folding in the area (pre-Westphalian) and the corresponding pole (24°N Latitude, 152°E Longitude) lies near the White Rock pole, suggesting a similar age of magnetization. The White Rock and Cheverie poles, which are constrained to have Early Carboniferous ages, are 30° or more away from the North American APW path over the same age range, a discrepancy which can be explained by a 15° to 19° northward motion of Meguma with respect to the North American craton along with a 20° to 25° counter-clockwise rotation. There is no Paleolatitude discrepancy between these results and paleomagnetic results from the adjacent Avalon Zone, although a similar rotational discrepancy is evident. These inferred motions of the Meguma Terrane most likely took place during the Carboniferous, prior to the formation of Pangea.

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*Plate Reconstruction from Paleozoic Paleomagnetism, eds. R. Van der Voo, C. R. Scotese, and N. Bonhommet; American Geophysical Union, Geodynamic Series, 1984, v. 12, p. 82-98.

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PALEOMAGNETIC RESULTS FROM THE CARBONIFEROUS OF NOVA SCOTIA*

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and P. S. Giles

ABSTRACT

Throughout the Carboniferous, North America and the southern continents of Gondwana were in collision. New paleomagnetic results from Nova Scotia are in agreement with other determinations from Maritime Canada which suggest that much of the eastern seaboard acted as a collage of microplates, bounded by strike-slip faults, moving in response to changes in the relative plate motion between North America and Gondwana. Paleomagnetic poles from the Early Carboniferous Horton (32N, 136E) and Windsor (36N, 137E) Groups, and the Late Carboniferous Morien Group (40N, 131E), indicate that during the mid-Carboniferous, Nova Scotia moved northwards out of the dry subtropics and into the equatorial rainy belt. Though Maritime Canada, as a whole, moved northward with respect to the craton along a zone of left-lateral faults (Norumbega-Fredericton Faults?), systematic southeasterly declinations in south-central Nova Scotia suggest that a small amount of right-lateral motion may have taken place along the Cobequid-Chedabucto Faults.

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*Plate Reconstruction from Paleozoic Paleomagnetism, eds. R. Van der Voo, C. R. Scotese, and N. Bonhommet; American Geophysical Union, Geodynamic Series, 1984, v. 12, p. 63-81.

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THE PALEOZOIC DRIFT OF AVALON BASEMENT TERRANE OF NOVA SCOTIA*

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ABSTRACT

The Avalon Zone in the northern Appalachians has been postulated to represent a coherent landmass accreted onto the North American continent. Paleomagnetic results from relatively unmetamorphosed Paleozoic rocks from Nova Scotia, north of the Cobequid-Chedabucto Fault, allow us to test the displaced terrane hypothesis. Rock units studied include (1) Middle Cambrian Bourinot Group mafic and felsic volcanics, (2) lavas and interbedded laterites of the latest Ordovician Dunn Point Formation, and (3) Late Devonian lavas and interbedded red sediments of the Fisset Brook Formation. Both the Bourinot and the Dunn Point rocks exhibit relatively simple magnetization histories as revealed by Zijderveld analysis, and possess magnetizations dating probably from the time of formation of the rocks or shortly thereafter. The resultant directions after tilt correction have steep inclinations (50-70°, with dual polarity for the Cambrian rocks). Both sediments and volcanics of the Fisset Brook Formation possess magnetizations comprised of multiple vector components which have overlapping stability spectra. Great-circle analysis nevertheless yields reasonably good estimates of the components for all sites, one of which (D/I=345/-35) was acquired before folding in post-Early Carboniferous time.

Together these results indicate Early Paleozoic paleolatitudes for Avalon of about 50° or greater, followed by movement toward lower latitudes before Late Devonian time. These results imply a large latitudinal separation between North America and Avalon in the Early Paleozoic which persisted until at least Late Ordovician time. Avalon might have collided with the southern Appalachian margin of North America in the Devonian but did not reach its present position with respect to North America until after the Early Carboniferous.

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*EOS, American Geophysical Union Transactions, v. 64, November 8, 1983, p. 690.

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NORTHERN APPALACHIANS ACCRETIONARY HISTORY*

J. D. Keppie and R. Smyth**

ABSTRACT

A new model for the northern Appalachians suggests that it is made up of a collage of terranes originating outboard of cratonic North America. Constraints on the time of accretion are provided by the age of the youngest strata unique to a particular terrane and the age of overstepping strata, straddling plutons, thrusts, straddling regional metamorphism and exotic pebbles. Using these criteria, it is possible to unravel the accretionary history of the northern Appalachians. During latest Precambrian times, the Avalon composite terrane was formed by the collision of several terranes resulting in the Cadomian Orogeny. In Late Cambrian-earliest Ordovician times the Boundary composite terrane was formed by collision of several terranes producing the Penobscot Disturbance. During Llanvirn-Caradocian times, terranes in the northwestern half of the Appalachians were accreted to cratonic North America. At the same time, terranes were accreted to the northern margin of the Avalon composite terrane. During the Devonian Acadian Orogeny, terranes were accreted to both sides of the Avalon composite terrane to form the Acadia composite terrane. This was followed in mid Carboniferous times by 1500 km sinistral transcurrent movement of the Acadian composite terrane from off Florida to its present location. Finally, terminal deformation in the Late Carboniferous and Permian Hercynian/Alleghanian Orogeny took place as Gondwana collided with North America.

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*Geological Society of America, Abstracts with Programs, 1983, v. 15, p. 196.

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PROCEEDINGS OF THE DEFORMATION STUDY GROUP, CALEDONIDE OROGEN PROJECT*

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INTRODUCTION

The NATO Advanced Study Institute - IGCP Caledonide Orogen Project Meeting in Fredericton, New Brunswick, Canada, in August 1982, provided the opportunity for members of the Deformation Study Group to compare structural maps of various parts of the Caledonide Orogen. This allowed the legends to be standardized, for some general conclusions to be made about the spatial distribution, nature and trends of structures throughout the entire orogen, and for some preliminary hypotheses to be formulated about their origin. These are presented here.

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*Regional Trends in the Geology of the Appalachian-Caledonian-Hercynian-Mauritanide Orogen, eds. P. E. Schenk, R. T. Haworth, J. D. Keppie, W. E. Trzcienski, P. F. Williams, and G. Kelling; NATO Advanced Study Institute, Series C, v. 116; D. Reidel Publishing Company, Boston, p. 275-278.

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TIMES OF DEFORMATION IN THE CANADIAN APPALACHIANS*

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and J. Bursnall[7]

This short paper summarizes the constraints on the times of deformation upon which the Structural Map of the Appalachian Orogen in Canada (1) was based. Space does not permit a detailed description of the structural styles, which may be found in (2) and references therein.

The times of deformation fall into several periods (Table 1): Mid Proterozoic or earlier (e.g. Grenvillian, Micmacian), Late Proterozoic (Cadomian = Avalonian), isolated Early Ordovician (Penobscotian), Mid-late Ordovician (Taconian), Devonian and possibly latest Silurian (Acadian) and Permo-Carboniferous (Hercynian).

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*Regional Trends in the Geology of the Appalachian-Caledonian-Hercynian-Mauritanide Orogen, eds. P. E. Schenk, R. T. Haworth, J. D. Keppie, W. E. Trzcienski, P. F. Williams and G. Kelling; NATO Advanced Study Institute, Series C, v. 116; D. Reidel Publishing Company, Boston, p. 307-314.

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Rb/Sr ISOCHRONS OF PRECAMBRIAN AGE FROM PLUTONIC ROCKS IN THE COBEQUID HIGHLANDS, NOVA SCOTIA

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GENERAL DESCRIPTION

During the summer of 1982 four granite gneiss bodies in the Bass River Complex (E-H on Fig. 1), the McCallum Settlement granite pluton (C on Fig. 1), and gneissic rocks from the Mt. Thom Complex (Fig. 1) were sampled for Rb/Sr isochron ages. The granite gneiss bodies and the granite pluton are located in the fault block bounded by the Cobequid and Rockland Brook Faults (Fig. 1). The Mt. Thom Complex gneisses are located at the eastern end of the Cobequid Highlands, north of the Rockland Brook Fault.

Previous ages on the Bass River Complex reported by Wanless et al. (1972) and recalculated by Keppie and Smith (1978) were K/Ar mineral ages from a biotite separate, 398 ± 17 Ma, and from a muscovite separate, 425 ± 17 Ma. The location of these dates are shown on Figure 1. Donohoe and Wallace (1980) have argued that these dates are too young because they have been reset by younger thermal and strain events such as the emplacement of the Pleasant Hills pluton (B on Fig. 1) and the strain effects created by movement on the Rockland Brook Fault. A Rb/Sr isochron on the granite gneisses would set minimum ages for the stratigraphic units intruded (Donohoe and Wallace, 1980; Donohoe, 1983).

In the east, the Mt. Thom Complex was undated, but was interpreted to be Hadrynian or older by Donohoe and Wallace (1980). Dating these orthogneisses would establish a minimum age for the Complex.

The McCallum Settlement pluton was chosen for dating because it intruded the Folly River Schist, but is not deformed with it. A previous Rb/Sr whole rock-mineral isochron from this pluton yielded a 504 ± 27 Ma age (Cormier, 1979).

The isochron diagrams shown in Figures 2 to 8 represent preliminary results. Work is continuing on these rocks at the geochronology laboratory at the University of New Hampshire.

ACKNOWLEDGMENTS

This radiometric dating in the Cobequid Highlands is part of a larger research project at the University of New Hampshire (HEG, WJO) on the ages of Precambrian rocks in the northern Appalachians. Funding for this work is provided through a National Science Foundation grant to Gaudette and Olszewski and assistance from the Nova Scotia Department of Mines and Energy.

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* Department of Earth Sciences, University of New Hampshire, Durham, New Hampshire.

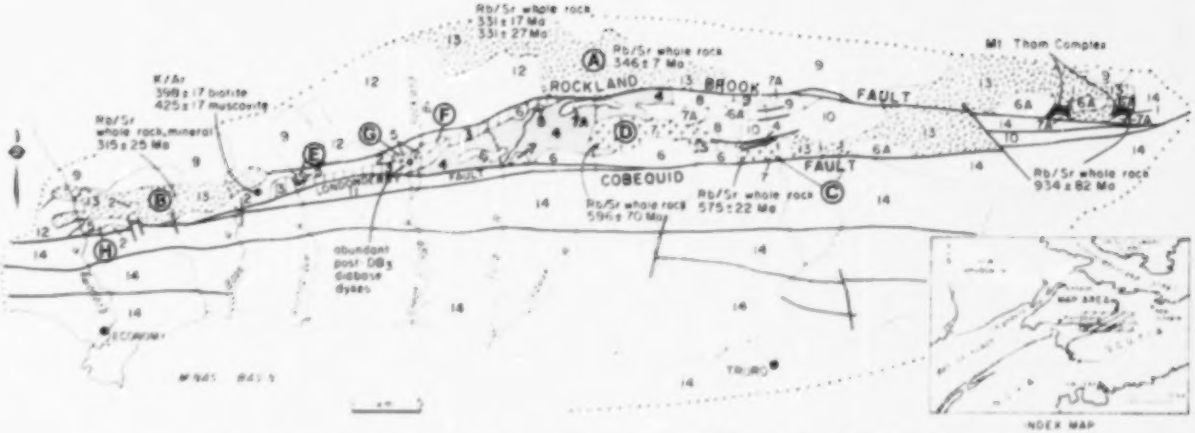
Rb/Sr whole rock
331 ± 17 Ma
331 ± 27 Ma
Rb/Sr whole rock
346 ± 7 Ma
K/Ar
398 ± 17 biotite
425 ± 17 muscovite
Rb/Sr
whole rock, mineral
315 ± 25 Ma
A
B
C
D
E
F
G
H
ROCKLAND
BROOK
FAULT
COBEQUID
FAULT
LONDONDERRY
abundant
post DB3
diabase
dykes
Rb/Sr whole rock
596 ± 70 Ma
Rb/Sr whole rock
575 ± 22 Ma
Mt Thom Complex
Rb/Sr whole rock
934 ± 82 Ma
TRURO
MAP AREA
INDEX MAP

Figure 1. Geological map of the Bass River Complex and Mt. Thom Complex.

LEGEND

EARLY, LATE CARBONIFEROUS AND LATE TRIASSIC

14 Undifferentiated HORTON, WINDSOR, CANSO, RIVERSDALE, PICTOU, and FUNDY GROUPS

EARLY TO "MIDDLE" CARBONIFEROUS

13 / 12 (13) Syenogranite to alkali feldspar granite
(12) Diorite

11 *LONDONDERRY FORMATION:* grey, green sandstone, siltstone

10 *NUTTBY FORMATION:* red-brown sandstone, grey siltstone

LATE ORDOVICIAN TO DEVONIAN

9 Undifferentiated sedimentary and volcanic rocks

EARLY CAMBRIAN OR OLDER

8 Unnamed sandstones, siltstones

7 / 7A / 6 / 6A (7) Granodiorite to syenogranite;
(7A) Granite (may be younger)
(6) Diorite; (6A) Diorite (may be younger)

HADRYNIAN OR OLDER

5 (5) Granite gneiss

4 / 3 BASS RIVER COMPLEX (2 to 4):
FOLLY RIVER SCHIST: green, mafic metavolcanic rocks
GAMBLE BROOK SCHIST: grey quartzite, biotite ± garnet + quartz schist

2 / 1 (2) *GREAT VILLAGE RIVER GNEISS:* grey feldspar-amphibole-quartz gneiss; amphibolite; granitoid gneiss
(1) MT. THOM COMPLEX: granitoid gneiss; feldspar-biotite-garnet gneiss; amphibolite

Plutons	Granite Gneiss Bodies
Ⓐ Hart Lake-Byers Lake	Ⓔ Portapique River
Ⓑ Pleasant Hills	Ⓕ Rockland Brook
Ⓒ McCallum Settlement	Ⓖ Great Village River
Ⓓ Debert River	Ⓗ Economy River

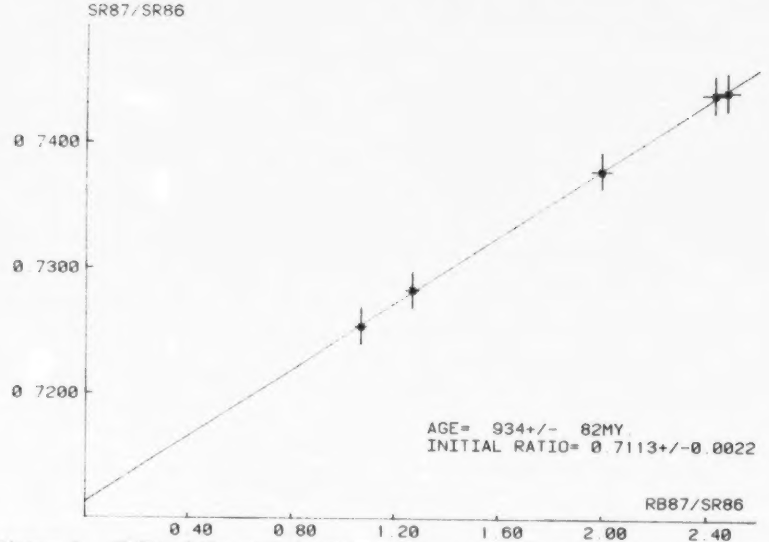

Figure 2. Rb/Sr whole rock isochron from granitoid orthogneiss in the Mt. Thom Complex. Location is given in Figure 1.

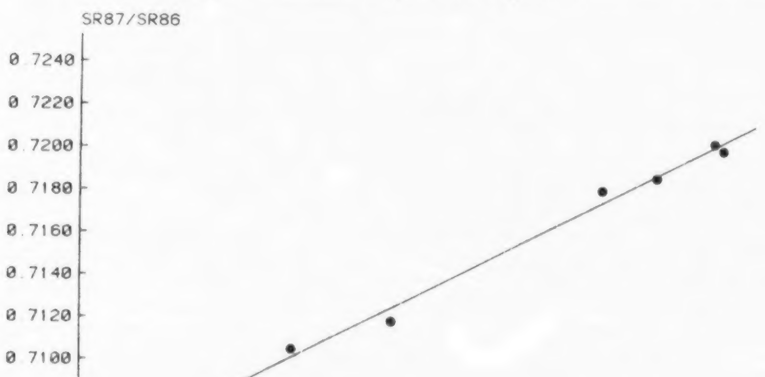

Figure 3. Rb/Sr whole rock isochron from the Rockland Brook granite gneiss body. Samples UNH159 and UNH160 are not included on the isochron.

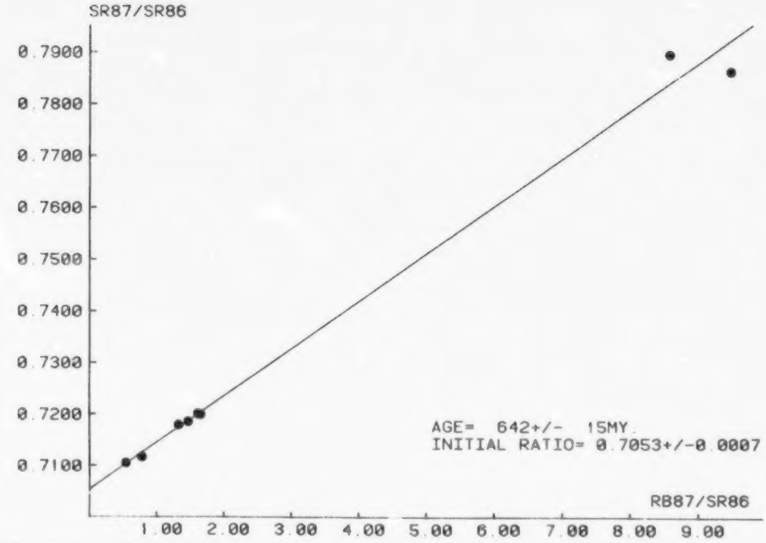

Figure 4. Rb/Sr whole rock isochron from the Rockland Brook granite gneiss body. All samples are included on the isochron.

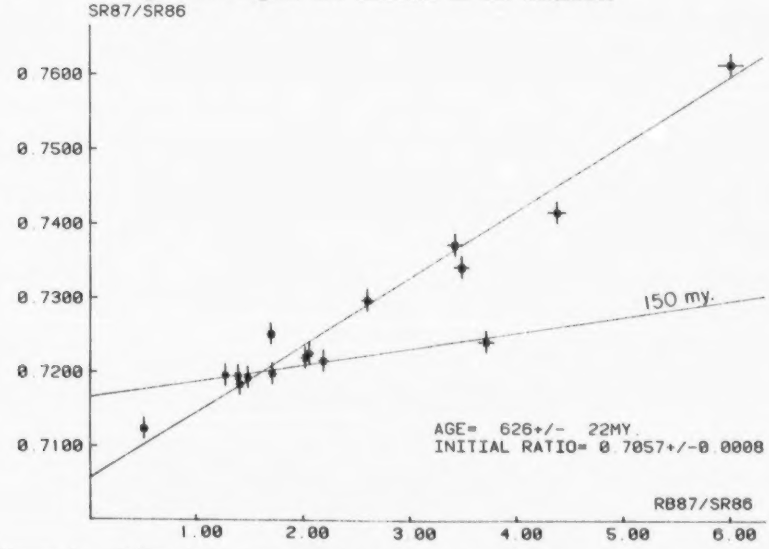

Figure 5. Rb/Sr whole rock isochron from the granite gneiss body on the Great Village River. Some of the data suggest a younger isochron.

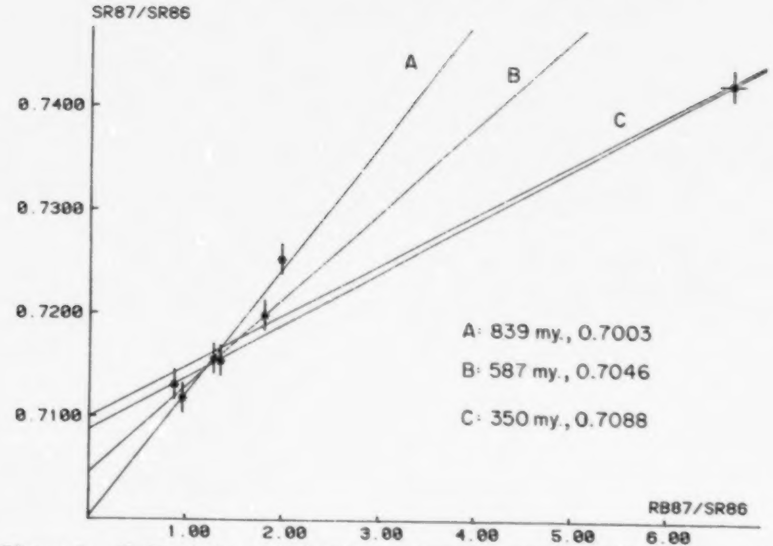

Figure 6. Rb/Sr whole rock isochrons from the granite gneiss body on the Portapique River. The data suggest several possible isochrons.

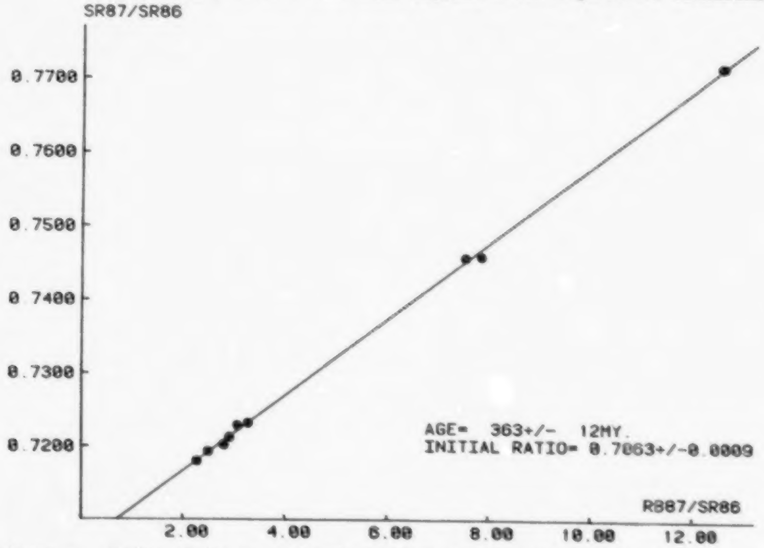

Figure 7. Rb/Sr whole rock isochron from the granite gneiss body on the Economy River.

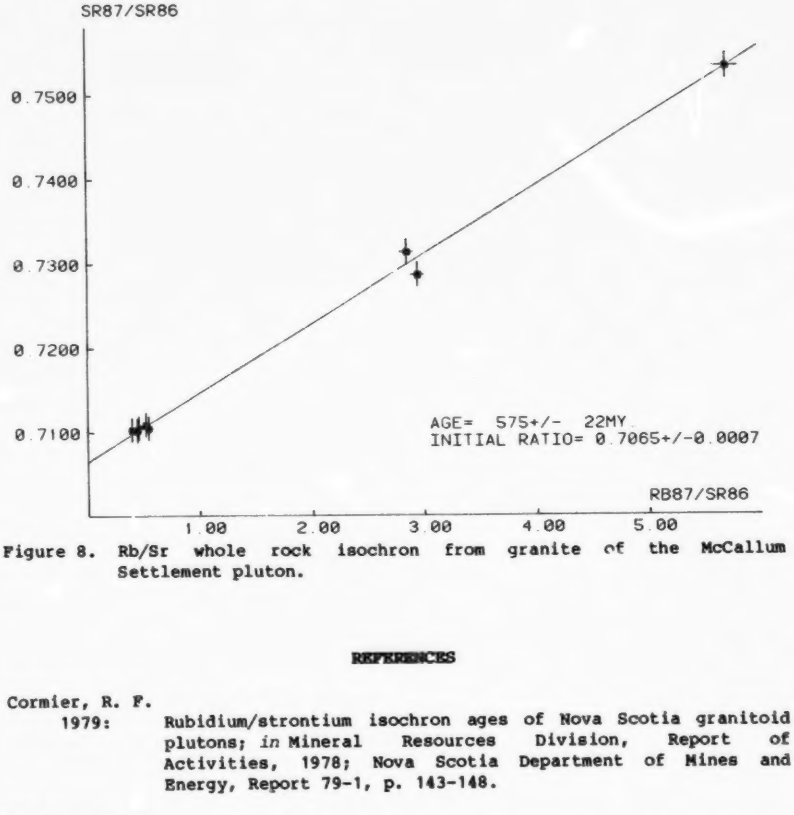

Figure 8. Rb/Sr whole rock isochron from granite of the McCallum Settlement pluton.

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EDUCATION AND PUBLIC AWARENESS

H. V. Donohoe, Jr.

The Mines and Minerals Branch established the Education and Public Awareness Program in 1982 to provide nontechnical information about the geology and mineral resources of the Province. Users of this information include the public, schools, and other government agencies. Such a program creates an increased awareness of the geology and mineral resources of Nova Scotia. Both the Department and the exploration and mining industry benefit by a better public image. Hopefully, the Program will also increase the number of informed people and organizations discussing problems such as exploration and mining guidelines, land use planning, and science education.

A wide range of program activities were either started or completed this year. For the first time, the Department had a booth at the Prospectors and Developers Association Convention. The Annual Report of the Department of Mines and Energy was better organized this year and published in a more timely manner. A pamphlet for "Sharing the Land", a campaign developed by the Voluntary Planning Board, described the rights of land owners, mineral rights, and the difference between exploration and mining. Press releases about the Branch's publications have made more people aware of the technical information we publish.

The course, "Prospecting and Geology in Nova Scotia", is being offered again this year. It is presented through the co-operation and financial assistance of the Nova Scotia Department of Mines and Energy, the Chamber of Mineral Resources of Nova Scotia, and the Department of Geology at Dalhousie University. Twenty people were enrolled in this fall's class, with nearly an equal number on the waiting list for the spring class. Land has already been staked as a result of the course. The Department and the Chamber of Mineral Resources are considering offering the course in other centres across the Province during 1984/85.

Two pamphlets, "Mining History of Nova Scotia", and the "Geological History of Nova Scotia", are in the manuscript stage. In addition, the Department and the Nova Scotia Museum are co-operating on informative "regional" brochures about the geology, geomorphology, and mineral resources of selected areas of the Province. The first of these brochures describes the Five Islands Park area of northern Nova Scotia. It is being developed in co-operation with the Museum, the Chamber of Mineral Resources of Nova Scotia, and the Nova Scotia Department of Lands and Forests. Several other projects underway will emphasize the importance of mineral resources, prospecting, exploration, and mining in social studies and science ciricula.

APPENDIX I

OPEN ASSESSMENT REPORTS FOR 1983

OPEN ASSESSMENT REPORTS FOR 1983

11D/10C 21-H-91(01)

GOLD, CROWS HILL LAKE, HALIFAX COUNTY, NOVA SCOTIA. PAN EAST RESOURCES INCORPORATED AND SANDER GEOPHYSICS LIMITED (FOR PAN EAST RESOURCES INCORPORATED). REPORT ON GEOLOGY, STREAM SEDIMENT GEOCHEMICAL SURVEY, AIRBORNE MAGNETIC AND AIRBORNE VLF SURVEYS, BY C. MILLER, 1982. 16 PAGES; 5 MAP(S) (PROPERTY LOCATION; STREAM SEDIMENT SAMPLE LOCATION; MAGNETIC, AIRBORNE; V L F, AIRBORNE)

11D/11C 21-H-39(11)

GOLD, LAWRENCETOWN, HALIFAX COUNTY, NOVA SCOTIA. DERRY, MICHENER AND BOOTH AND DEJOUR MINES LIMITED (FOR A. HUDGINS). REPORT ON ROCK GEOCHEMISTRY, TRENCHING AND PROPOSED DRILLING PROGRAM, BY D. J. ARCHER, 1980. 18 PAGES; 3 MAP(S) (PROPERTY LOCATION; MINE SURFACE PLANS)

11D/11C 21-H-39(12)

GOLD, LAWRENCETOWN, HALIFAX COUNTY, NOVA SCOTIA. DERRY, MICHENER AND BOOTH (FOR A. D. HUDGINS). REPORT ON GEOLOGY AND DRILLING, BY A. D. HUDGINS. 1983. 26 PAGES; 1 MAP(S) (DRILL HOLE LOCATION); DRILL HOLE LOGS

11D/11D 21-H-27(01)

GOLD, LAKE CATCHA, HALIFAX COUNTY, NOVA SCOTIA. P. A. R. BROWN (FOR SYCON ENERGY CORPORATION). REPORT ON GROUND MAGNETIC AND GROUND VLF SURVEYS AND DRILLING, BY P. A. R. BROWN, 1981. 13 PAGES; 6 MAP(S) (PROPERTY LOCATION; TOPOGRAPHIC; MAGNETIC, GROUND; V L F, GROUND); DRILL HOLE LOGS; PHOTOGRAPHS; DRILL HOLE SECTIONS

11D/14A 07-H-51(02)

BASE METALS, MUSQUODOBOIT HARBOUR, HALIFAX COUNTY, NOVA SCOTIA. NORANDA EXPLORATION COMPANY LIMITED AND JOHNSTON GEOPHYSICS LIMITED (FOR NORANDA EXPLORATION COMPANY LIMITED). REPORT ON IP, GROUND MAGNETIC AND GROUND VLF SURVEYS, BY G. GRAVES, 1981. 7 PAGES; 3 MAP(S) (PROPERTY LOCATION; I P LINES LOCATION; V L F LINES LOCATION; SOIL GEOCHEMICAL; V L F, GROUND); GEOCHEMICAL PROFILES; V L F PROFILES; PSEUDO SECTIONS; MAGNETIC PROFILES

11D/15A 21-H-67(18)

GOLD, TANGIER, HALIFAX COUNTY, NOVA SCOTIA. JEAN DEPATIE AND ASSOCIATES (FOR L. BLONDEAU). REPORT ON THE ALLUVIAL GOLD CONTENT OF COPPER LAKE, BY J. DEPATIE, 1980. 30 PAGES; 7 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION; SUBSURFACE TOPOGRAPHIC); CROSS SECTIONS

11D/15A 21-H-67(19)

GOLD, TANGIER, HALIFAX COUNTY, NOVA SCOTIA. JEAN DEPATIE AND ASSOCIATES (FOR L. BLONDEAU). REPORT ON GOLD POTENTIAL OF THE TANGIER GOLD DISTRICT, BY J. DEPATIE, 1980. 30 PAGES; 3 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION)

11D/15A 51-H-67(01)

TIN, TANGIER, HALIFAX COUNTY, NOVA SCOTIA. SHELL CANADA RESOURCES LIMITED. REPORT ON GEOLOGICAL SURVEY, TILL AND ROCK GEOCHEMICAL SURVEYS, BY G. MACGILLIVRAY, A. J. D. KENDALL, 1981. 16 PAGES; 13 MAP(S) (PROPERTY LOCATION; ROCK SAMPLE LOCATION; TILL SAMPLE LOCATION; GEOLOGICAL; SURFICIAL GEOLOGY; TILL GEOCHEMICAL)

11D/15A 51-H-67(02)

TIN, TANGIER, HALIFAX COUNTY, NOVA SCOTIA. ESSO RESOURCES CANADA LIMITED (FOR ESSO RESOURCES CANADA LIMITED AND W. B. DUNLOP). REPORT ON GEOLOGICAL, STREAM SEDIMENT AND TILL HEAVY MINERALS GEOCHEMICAL SURVEYS, BY J. L. MACLEOD, 1981. 26 PAGES; 7 MAP(S) (PROPERTY LOCATION; HEAVY MINERALS SAMPLE LOCATION; ROCK SAMPLE LOCATION; TILL SAMPLE LOCATION; GEOLOGICAL; HEAVY MINERALS GEOCHEMICAL; TILL GEOCHEMICAL)

11D/15B 31-H-29(07)

MANGANESE, LAKE CHARLOTTE, HALIFAX COUNTY, NOVA SCOTIA. J. A. LESLIE AND ASSOCIATES LIMITED (FOR MINOREX LIMITED). REPORT ON EXPLORATION HISTORY, GEOLOGICAL EVALUATIONS AND ROCK SAMPLING, BY J. A. LESLIE, 1981. 15 PAGES; 3 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION; GEOLOGICAL; ROCK GEOCHEMICAL)

11D/15C 21-H-49(05)

GOLD, MOOSE RIVER, HALIFAX COUNTY, NOVA SCOTIA. SHERRITT GORDON MINES LIMITED (FOR J. LOGAN). GRID LOCATION MAP, BY SHERRITT GORDON MS L, 1981. 1 MAP(S) (PROPERTY LOCATION)

11D/16C 21-H-23(08)

GOLD, HARRIGAN COVE, HALIFAX COUNTY, NOVA SCOTIA. LAKEFIELD RESEARCH OF CANADA LIMITED (FOR HARRIGAN MINING ASSOCIATES). REPORT ON GRAVITY SEPARATION, AMALGAMATION AND COLUMN LEACHING RECOVERY TECHNIQUES, BY W. T. YEN, C. GARRETT, D. M. WYSLOUZIL, 1981. 27 PAGES

11D/16C 21-H-23(09)

GOLD, HARRIGAN COVE, HALIFAX COUNTY, NOVA SCOTIA. HARRIGAN MINING ASSOCIATES. REPORT ON RECONNAISSANCE GEOLOGICAL AND SOIL GEOCHEMICAL SURVEYS, BY W. A. MACPHERSON, 1982. 6 PAGES; 1 MAP(S) (PROPERTY LOCATION)

11D/16C 21-H-63(16)

GOLD, SALMON RIVER, HALIFAX COUNTY, NOVA SCOTIA. PAN EAST RESOURCES INCORPORATED AND SANDER GEOPHYSICS LIMITED (FOR PAN EAST RESOURCES INCORPORATED). REPORT ON GEOLOGY, BIOGEOCHEMICAL SURVEY, STREAM SEDIMENT GEOCHEMICAL SURVEY, AIRBORNE MAGNETIC AND AIRBORNE VLF SURVEYS, BY C. MILLER, 1982. 17 PAGES; 6 MAP(S) (PROPERTY LOCATION; STREAM SEDIMENT SAMPLE LOCATION; BIOGEOCHEMICAL; MAGNETIC, AIRBORNE; V L F, AIRBORNE)

11D/16C 21-H-63(17)

GOLD, SALMON RIVER (DUFFERIN MINE), HALIFAX COUNTY, NOVA SCOTIA. SULPETRO MINERALS LIMITED. REPORT ON DRILLING, BY A. L. SANGSTER, 1981. 4 PAGES; 1 MAP(S) (DRILL HOLE LOCATION); DRILL HOLE LOGS; MINE CROSS SECTIONS; DRILL HOLE SECTIONS

11D/16D 21-H-12(03)

GOLD, ECUM SECUM, HALIFAX COUNTY, NOVA SCOTIA. DEJOUR MINES LIMITED AND DERRY, MICHENER AND BOOTH (FOR SEVILLE DEVELOPMENTS CORPORATION). REPORT ON BIOGEOCHEMICAL SURVEY AND GROUND VLF SURVEY, BY W. N. PEARSON, 1980. 5 PAGES; 3 MAP(S) (VEGETATION TYPE; BIOGEOCHEMICAL; V L F, GROUND)

11D/16D 21-H-12(04)

GOLD, ECUM SECUM, HALIFAX COUNTY, NOVA SCOTIA. W. A. MACPHERSON (FOR ATLANTIC GOLD MINES LIMITED). REPORT ON MINING HISTORY, PAST DRILLING AND PROPOSED EXPLORATION RECOMMENDATIONS, BY W. A. MACPHERSON, 1981. 19 PAGES; 4 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION; MINE SURFACE PLANS); MINE CROSS SECTIONS

11D/16D 21-H-12(05)

GOLD, ECUM SECUM, HALIFAX COUNTY, NOVA SCOTIA. A. D. HUDGINS (FOR ATLANTIC GOLD MINES LIMITED). REPORT ON MINING HISTORY AND PROPOSED EXPLORATION RECOMMENDATIONS, BY A. D. HUDGINS, 1981. 3 PAGES

11E/01A 21-G-17(15)

GOLD, GOLDENVILLE, GUYSBOROUGH COUNTY, NOVA SCOTIA. NORTHUMBERLAND MINES LIMITED AND SANDER GEOPHYSICS LIMITED (FOR W. L. YOUNG). REPORT ON GEOLOGICAL, TAILINGS AND BIOGEOCHEMICAL SURVEYS, GROUND EM, AIRBORNE MAGNETIC AND AIRBORNE VLF SURVEYS, DRILLING AND THIN SECTION MICROSCOPY, BY E. D. HARRINGTON, W. R. ARCHER, H. J. BROOME, 1981. 181 PAGES; 12 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION; GEOLOGICAL; BIOGEOCHEMICAL; E M, GROUND; MAGNETIC, AIRBORNE; V L F, AIRBORNE; MINE TAILINGS; MINE SURFACE PLANS); DRILL HOLE LOGS

11E/01A 21-G-31(06)

GOLD, MILLER LAKE, GUYSBOROUGH COUNTY, NOVA SCOTIA. A. M. FREW (FOR A. D. HUDGINS). REPORT ON MINING HISTORY AND PROPOSED EXPLORATION RECOMMENDATIONS, BY A. M. FREW, 1981. 14 PAGES; 3 MAP(S) (PROPERTY LOCATION)

11E/01A 21-G-31(07)

GOLD, MILLER LAKE, GUYSBOROUGH COUNTY, NOVA SCOTIA. A. D. HUDGINS (FOR ATLANTIC GOLD MINES LIMITED). REPORT ON MINING HISTORY AND PROPOSED EXPLORATION RECOMMENDATIONS, BY A. D. HUDGINS, 1981. 4 PAGES

11E/01B 21-G-63(01)

GOLD, BEAR LAKE, GUYSBOROUGH COUNTY, NOVA SCOTIA. PAN EAST RESOURCES AND SANDER GEOPHYSICS LIMITED (FOR PAN EAST RESOURCES INCORPORATED). REPORT ON GEOLOGY, STREAM SEDIMENT GEOCHEMICAL SURVEY, AIRBORNE MAGNETIC AND AIRBORNE VLF SURVEYS, BY C. MILLER, 1982. 16 PAGES; 4 MAP(S) (PROPERTY LOCATION STREAM SEDIMENT SAMPLE LOCATION; MAGNETIC, AIRBORNE; V L F, AIRBORNE)

11E/01B 21-H-89(01)

GOLD, WILSONS FALLS, HALIFAX COUNTY, NOVA SCOTIA. PAN EAST RESOURCES INCORPORATED AND SANDER GEOPHYSICS LIMITED (FOR PAN EAST RESOURCES INCORPORATED). REPORT ON GEOLOGY, STREAM SEDIMENT GEOCHEMICAL SURVEY, AIRBORNE MAGNETIC AND AIRBORNE VLF SURVEYS, BY C. MILLER, 1982. 15 PAGES; 5 MAP(S) (PROPERTY LOCATION; STREAM SEDIMENT SAMPLE LOCATION; MAGNETIC, AIRBORNE; VLF, AIRBORNE)

11E/01D 21-G-05(14)

GOLD, COCHRANE HILL, GUYSBOROUGH COUNTY, NOVA SCOTIA. NORTHUMBERLAND MINES LIMITED AND SANDER GEOPHYSICS LIMITED (FOR MASSVAL MINES LIMITED). REPORT ON GEOLOGICAL AND BIOGEOCHEMICAL SURVEYS, AIRBORNE MAGNETIC, AIRBORNE VLF AND GROUND EM SURVEYS AND DRILLING, BY E. HARRINGTON, G. W. SANDER, W. R. ARCHER, 1981. 462 PAGES; 9 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION; GEOLOGICAL; BIOGEOCHEMICAL; E M, GROUND; MAGNETIC, AIRBORNE; V L F, AIRBORNE); CROSS SECTIONS; DRILL HOLE LOGS

11E/01D 21-G-05(15)

GOLD, COCHRANE HILL, GUYSBOROUGH COUNTY, NOVA SCOTIA. NORTHUMBERLAND MINES LIMITED. REPORT ON GEOLOGICAL, BIOGEOCHEMICAL AND GROUND EM SURVEYS, BY E. D. HARRINGTON, 1981. 13 PAGES; 7 MAP(S) (PROPERTY LOCATION; GEOLOGICAL; BIOGEOCHEMICAL; E M, GROUND)

11E/02A 21-H-01(06)

GOLD, BEAVER DAM, HALIFAX COUNTY, NOVA SCOTIA. COMIESA CORPORATION (FOR M. E. X. EXPLORATIONS LIMITED). REPORT ON DRILLING, BY A. D. HUDGINS, 1981. 142 PAGES; 2 MAP(S) (DRILL HOLE LOCATION; DRILL CORE GEOCHEMICAL; MINE SURFACE PLANS; MINE LEVEL PLANS); DRILL HOLE LOGS; DRILL HOLE SECTIONS

11E/02A 21-H-25(07)

GOLD, KILLAG, HALIFAX COUNTY, NOVA SCOTIA. PAN EAST RESOURCES INCORPORATED AND TERRA PHOTO INTERNATIONAL LIMITED (FOR MAZEL MINING COMPANY LIMITED). REPORT ON PHOTO GEOLOGY, STREAM SEDIMENT, SOIL AND ROCK GEOCHEMICAL SURVEYS, BIOGEOCHEMICAL SURVEY AND ELECTRON MICROPROBE ANALYSES, BY C. MILLER, 1981. 15 PAGES; 5 MAP(S) (PROPERTY LOCATION; GEOLOGICAL; BIOGEOCHEMICAL; STREAM SEDIMENT GEOCHEMICAL)

11E/02A 21-H-25(08)

GOLD, KILLAG, HALIFAX COUNTY, NOVA SCOTIA. PAN EAST RESOURCES LIMITED (FOR W. LOCKERBY). REPORT ON GEOLOGY, STREAM SEDIMENT GEOCHEMICAL AND BIOGEOCHEMICAL SURVEYS, BY C. MILLER, 1981. 10 PAGES; 4 MAP(S) (PROPERTY LOCATION; BIOGEOCHEMICAL; STREAM SEDIMENT GEOCHEMICAL)

11E/02A 54-H-85(01)

URANIUM, LAKE MULGRAVE, HALIFAX COUNTY, NOVA SCOTIA. AQUITAINE COMPANY OF CANADA LIMITED. REPORT ON GEOLOGICAL, SOIL AND STREAM SEDIMENT GEOCHEMICAL SURVEYS AND GROUND RADIOMETRIC SURVEY, BY D. W. POLLOCK, 1981. 7 PAGES; 7 MAP(S) (SOIL SAMPLE LOCATION; STREAM SEDIMENT SAMPLE LOCATION; GEOLOGICAL; SOIL GEOCHEMICAL; STREAM SEDIMENT GEOCHEMICAL; RADIOMETRIC, GROUND)

11E/02B 21-H-07(14)

GOLD, CARIBOU, HALIFAX COUNTY, NOVA SCOTIA. J. E. DAWE. REPORT ON ROCK GEOCHEMICAL AND BIOGEOCHEMICAL SURVEYS, BY J. E. DAWE, 1981. 7 PAGES; 5 MAP(S) (PROPERTY LOCATION; BIOGEOCHEMICAL SAMPLE LOCATION; ROCK SAMPLE LOCATION; ROCK GEOCHEMICAL)

11E/02B 21-H-07(15)

GOLD, CARIBOU, HALIFAX COUNTY, NOVA SCOTIA. SHERRIT GORDON MINES LIMITED (FOR J. LOGAN ENTERPRISES LIMITED AND K. BURROWS). REPORT ON GROUND EM SURVEY AND DRILLING, BY B. ATKINSON, 1981. 198 PAGES; 14 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION; E M, GROUND); DRILL HOLE SECTIONS; DRILL HOLE LOGS

11E/02B 21-H-07(16)

GOLD, CARIBOU, HALIFAX COUNTY, NOVA SCOTIA. SHERRITT GORDON MINES LIMITED (FOR JOHN LOGAN ENTERPRISES LIMITED AND K. BURROWS). REPORT ON GROUND EM SURVEY, BY B. ATKINSON, 1981. 7 PAGES; 9 MAP(S) (PROPERTY LOCATION; E M, M, GROUND; E M LINES LOCATION)

11E/02B 21-H-74(04)

GOLD, WINE LAKE, HALIFAX COUNTY, NOVA SCOTIA. SULPETRO MINERALS LIMITED. REPORT ON IP SURVEY, BY J. L. WRIGHT, 1981. 5 PAGES; 1 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION); PSEUDO SECTIONS

11E/02D 21-H-13(10)

GOLD, FIFTEEN MILE STREAM, HALIFAX COUNTY, NOVA SCOTIA. ST. JOSEPH EXPLORATIONS LIMITED. REPORT ON TILL GEOCHEMICAL AND BIOGEOCHEMICAL SURVEYS, BY W. P. BINNEY, 1981. 4 PAGES; 6 MAP(S) (BIOGEOCHEMICAL SAMPLE LOCATION; TILL SAMPLE LOCATION; BIOGEOCHEMICAL; TILL GEOCHEMICAL)

11E/03A 21-H-28(01)

GOLD, LINDSAY LAKE, HALIFAX COUNTY, NOVA SCOTIA. J. E. DAWE (FOR TRI-EXPLORATIONS LIMITED). REPORT ON PROSPECTING AND ROCK GEOCHEMISTRY, BY J. E. DAWE, 1982. 9 PAGES; 3 MAP(S) (PROPERTY LOCATION; MINE SURFACE PLANS)

11E/03A 41-H-20(01)

SILICA, ELMSVALE, HALIFAX COUNTY, NOVA SCOTIA. NOVA SCOTIA SAND AND GRAVEL (FOR L. E. SHAW LIMITED). REPORT ON DRILLING, BY S. SMITH, 1981. 107 PAGES; 1 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION); DRILL HOLE LOGS

11E/03B 27-H-14(33)

LEAD, GAYS RIVER, COLCHESTER COUNTY, NOVA SCOTIA. ESSO RESOURCES CANADA LIMITED. REPORT ON GEOLOGY AND DRILLING, BY V. L. HANNON, 1975. 91 PAGES 4 MAP(S) (GEOLOGICAL; DRILL HOLE LOCATION); DRILL HOLE LOGS; DRILL HOLE SECTIONS

11E/03D 21-D-73(01)

GOLD, ST ANDREWS RIVER, COLCHESTER COUNTY, NOVA SCOTIA. PLACER DEVELOPMENT LIMITED. REPORT ON SOIL GEOCHEMICAL SURVEY, HEAVY MINERAL EXAMINATION AND DRILLING, BY C. KEECH, D. D. DAVIDSON, 1981. 71 PAGES; 10 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION; HEAVY MINERALS SAMPLE LOCATION; SOIL GEOCHEMICAL); STRATIGRAPHIC CHARTS; DRILL HOLE LOGS; DRILL HOLE SECTIONS

11E/03D 21-D-73(02)

GOLD, ST ANDREWS RIVER, COLCHESTER COUNTY, NOVA SCOTIA. PLACER DEVELOPMENT LIMITED. REPORT ON DRILLING, BY C. KEECH, 1982. 21 PAGES; 3 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION); STRATIGRAPHIC CHARTS; DRILL HOLE LOGS; DRILL HOLE SECTIONS

11E/04A 21-I-62(01)

GOLD, NINE MILE RIVER, HANTS COUNTY, NOVA SCOTIA. G. W. LAFORME (FOR G. R. LAFORME). REPORT ON SOIL AND ROCK GEOCHEMICAL SURVEYS, BY G. W. LAFORME, 1980. 14 PAGES; 6 MAP(S) (PROPERTY LOCATION; ROCK SAMPLE LOCATION; SOIL SAMPLE LOCATION; ROCK GEOCHEMICAL; SOIL GEOCHEMICAL)

11E/04A 41-I-62(02)

SILICA, NINE MILE RIVER, HANTS COUNTY, NOVA SCOTIA. L. E. SHAW LIMITED. REPORT ON PROSPECTING AND DRILLING 1981. 6 PAGES; 1 MAP(S) (DRILL HOLE LOCATION); DRILL HOLE LOGS

11E/04A 41-I-62(03)

SILICA, NINE MILE RIVER, HANTS COUNTY, NOVA SCOTIA. L. E. SHAW LIMITED AND NOVA SCOTIA SAND AND GRAVEL (FOR L. E. SHAW LIMITED). REPORT ON PROSPECTING AND DRILLING, BY S. SMITH, 1981. 5 PAGES; 1 MAP(S) (DRILL HOLE LOCATION); DRILL HOLE LOGS

11E/04B 21-I-33(08)

GOLD, CENTRAL RAWDON, HANTS COUNTY, NOVA SCOTIA. AMERIC MINES LIMITED. REPORT ON DRILLING, BY D. L. BLACK, 1981. 6 PAGES; 1 MAP(S) (DRILL HOLE LOCATION); DRILL HOLE LOGS

11E/04B 21-I-33(09)

GOLD, CENTRAL RAWDON, HANTS COUNTY, NOVA SCOTIA. AMERIC MINES LIMITED. REPORT ON PROSPECTING, SP AND GROUND EM SURVEYS AND DRILLING, BY D. L. BLACK, 1981. 18 PAGES; 5 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION; MINE SURFACE PLANS; S P; E M, GROUND); DRILL HOLE LOGS

11E/04B 21-I-55(01)

GOLD, WEST GORE, HANTS COUNTY, NOVA SCOTIA. A. D. HUDGINS (FOR ATLANTIC GOLD MINES LIMITED). REPORT ON MINING HISTORY AND PROPOSED EXPLORATION RECOMMENDATIONS, BY A. D. HUDGINS, 1981. 3 PAGES

11E/04B 40-I-17(01)

POTASH, KENNETCOOK, HANTS COUNTY, NOVA SCOTIA. COMINCO LIMITED AND ALLAN SPECTOR AND ASSOCIATES LIMITED (FOR COMINCO LIMITED). REVIEW AND INTERPRETATION OF EXISTING AEROMAGNETIC AND GRAVITY DATA AND A REPORT ON GROUND GRAVITY SURVEY, BY K. N. HENDRY, A. SPECTOR, 1981. 29 PAGES; 12 MAP(S) (PROPERTY LOCATION; TOPOGRAPHIC; GEOLOGICAL; STRUCTURAL; ISOPACHS; GRAVITY, GROUND)

11E/04B 40-I-17(02)

POTASH, KENNETCOOK, HANTS COUNTY, NOVA SCOTIA. COMINCO LIMITED. REPORT ON DRILLING PREPARATIONS, BY R. N. RANDELL, 1982. 5 PAGES; 1 MAP(S) (PROPERTY LOCATION)

11E/04C 07-I-51(01)

BASE METALS, WALTON, HANTS COUNTY, NOVA SCOTIA. GULF MINERALS CANADA LIMITED. REPORT ON GEOLOGY AND DRILLING, BY R. T. BOYD, 1981. 38 PAGES; MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION); DRILL HOLE LOGS; DRILL HOLE SECTIONS; STRATIGRAPHIC CHARTS; STRATIGRAPHIC COLUMNS

11E/04C 07-I-51(02)

BASE METALS, WALTON, HANTS COUNTY, NOVA SCOTIA. GULF MINERALS CANADA LIMITED. REPORT ON GEOLOGY, OVERBURDEN GEOCHEMISTRY AND DRILLING, BY R. T. BOYD, 1982. 88 PAGES; 3 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION); STRATIGRAPHIC CHARTS; STRATIGRAPHIC COLUMNS; DRILL HOLE LOGS; DRILL HOLE SECTIONS

11E/04C 07-I-51(03)

BASE METALS, WALTON, HANTS COUNTY, NOVA SCOTIA. GULF MINERALS CANADA LIMITED. REPORT ON OVERBURDEN GEOCHEMISTRY AND DRILLING, BY R. T. BOYD, 1982. 8 PAGES; 2 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION); DRILL HOLE LOGS

11E/05B 07-I-49(03)

BASE METALS, TENNYCAPE, HANTS COUNTY, NOVA SCOTIA. GULF MINERALS CANADA LIMITED. REPORT ON GEOLOGY AND DRILLING, BY R. T. BOYD, 1981. 74 PAGES; 3 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION); STRATIGRAPHIC CHARTS STRATIGRAPHIC COLUMNS; DRILL HOLE LOGS; DRILL HOLE SECTIONS

11E/05B 07-I-49(04)

BASE METALS, TENNYCAPE, HANTS COUNTY, NOVA SCOTIA. GULF MINERALS CANADA LIMITED. REPORT ON GEOLOGY AND DRILLING, BY R. T. BOYD, 1981. 19 PAGES; 3 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION); STRATIGRAPHIC CHARTS; STRATIGRAPHIC COLUMNS; DRILL HOLE LOGS; DRILL HOLE SECTIONS

11E/05C 06-D-01(04)

BARITE, BASS RIVER, COLCHESTER COUNTY, NOVA SCOTIA. J. A. LESLIE AND ASSOCIATES LIMITED AND NOVA SCOTIA RESEARCH FOUNDATION (FOR ATLANTIC BARITE COMPANY LIMITED). REPORT ON GEOLOGICAL, SOIL GEOCHEMICAL, GROUND GRAVITY AND GROUND VLF SURVEYS AND DRILLING, BY J. A. LESLIE, 1981. 34 PAGES; 3 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION; E M LINES LOCATION; GRAVITY LINES LOCATION; GEOLOGICAL; SOIL GEOCHEMICAL); GRAVITY PROFILES; E M PROFILES; DRILL HOLE LOGS

11E/05D 07-D-33(08)

BASE METALS, LONDONDERRY, COLCHESTER COUNTY, NOVA SCOTIA. COMINCO LIMITED AND ALAN SPECTOR AND ASSOCIATES LIMITED (FOR COMINCO LIMITED). REPORT ON GEOLOGICAL AND STREAM SEDIMENT GEOCHEMICAL SURVEYS AND MAGNETIC INTERPRETATIONS, BY R. N. RANDELL, 1981. 11 PAGES; 6 MAP(S) (PROPERTY LOCATION; STREAM SEDIMENT SAMPLE LOCATION; GEOLOGICAL; GEOLOGICAL; FACIES; STRUCTURAL; STREAM SEDIMENT GEOCHEMICAL)

11E/07A 07-D-72(01)

BASE METALS, PICTOU LAKE, COLCHESTER COUNTY, NOVA SCOTIA. AQUITAINE COMPANY OF CANADA LIMITED. REPORT ON GEOLOGICAL, SOIL, STREAM SEDIMENT GEOCHEMICAL AND AIRBORNE RADIOMETRIC SURVEYS, BY D. W. POLLOCK, 1980. 9 PAGES; 14 MAP(S) (PROPERTY LOCATION; STREAM SEDIMENT SAMPLE LOCATION; GEOLOGICAL; STREAM SEDIMENT GEOCHEMICAL; SOIL GEOCHEMICAL; RADIOMETRIC, AIRBORNE; RADIOMETRIC, GROUND)

11E/07A 07-G-60(01)

BASE METALS, TRAFALGAR, GUYSBOROUGH COUNTY, NOVA SCOTIA. ST. JOSEPH EXPLORATIONS LIMITED. REPORT ON BIOGEOCHEMICAL SURVEY AND SOIL AND STREAM SEDIMENT GEOCHEMICAL SURVEYS, BY W. P. BINNEY, 1981. 4 PAGES; 8 MAP(S) (BIOGEOCHEMICAL SAMPLE LOCATION; SOIL SAMPLE LOCATION; STREAM SEDIMENT SAMPLE LOCATION; BIOGEOCHEMICAL; SOIL GEOCHEMICAL; STREAM SEDIMENT GEOCHEMICAL)

11E/07A 07-G-60(02)

BASE METALS, TRAFALGAR, GUYSBOROUGH COUNTY, NOVA SCOTIA. ST. JOSEPH EXPLORATIONS LIMITED. REPORT ON SOIL GEOCHEMICAL, GROUND EM AND GROUND MAGNETIC SURVEYS, BY A. L. SANGSTER, 1981. 5 PAGES; 9 MAP(S) (SOIL SAMPLE LOCATION; SOIL GEOCHEMICAL; E M, GROUND; MAGNETIC, GROUND)

11E/07A 07-G-60(03)

BASE METALS, TRAFALGAR, GUYSBOROUGH COUNTY, NOVA SCOTIA. ST. JOSEPH EXPLORATIONS LIMITED. REPORT ON OVERBURDEN DRILLING AND TILL GEOCHEMISTRY, BY A. L. SANGSTER, 1981. 4 PAGES; 7 MAP(S) (DRILL HOLE LOCATION; OVERBURDEN THICKNESS; TILL GEOCHEMICAL; MAGNETIC, GROUND; TILL SAMPLE LOCATION)

11E/07B 07-D-18(09)

BASE METALS, EASTVILLE, COLCHESTER COUNTY, NOVA SCOTIA. ST. JOSEPH EXPLORATIONS LIMITED. REPORT ON OVERBURDEN DRILLING AND TILL GEOCHEMISTRY, BY W. P. BINNEY, 1981. 52 PAGES; 37 MAP(S) (TILL SAMPLE LOCATION; DRILL HOLE LOCATION; GEOLOGICAL; TILL GEOCHEMICAL); STRATIGRAPHIC CHARTS; CROSS SECTIONS; DRILL HOLE SECTIONS; GEOCHEMICAL PROFILES

11E/07B 07-D-18(10)

BASE METALS, EASTVILLE, COLCHESTER COUNTY, NOVA SCOTIA. SULPETRO MINERALS LIMITED. REPORT ON GEOLOGICAL SURVEY, BY W. P. BINNEY, 1981. 4 PAGES; 1 MAP(S) (GEOLOGICAL)

11E/07B 07-D-23(07)

BASE METALS, GLENBERVIE, COLCHESTER COUNTY, NOVA SCOTIA. ESSO RESOURCES CANADA LIMITED. REPORT ON DRILLING, BY J. L. MACLEOD, 1978. 43 PAGES; 5 MAP(S) (GEOLOGICAL; DRILL HOLE LOCATION; PROPERTY LOCATION; SOIL SAMPLE LOCATION); DRILL HOLE LOGS; DRILL HOLE SECTIONS

11E/08A 21-G-05(02)

GOLD, COCHRANE HILL, GUYSBOROUGH COUNTY, NOVA SCOTIA. NORTHUMBERLAND MINES LIMITED. REPORT ON GEOLOGICAL AND GROUND EM SURVEYS, BY E. D. HARRINGTON, 1981. 27 PAGES; 6 MAP(S) (PROPERTY LOCATION; GEOLOGICAL; E M, GROUND)

11E/09A 07-B-23(06)

BASE METALS, OHIO, ANTIGONISH COUNTY, NOVA SCOTIA. ESSO RESOURCES CANADA LIMITED (FOR ESSO RESOURCES CANADA LIMITED AND H. D. MACGILLIVARY). REPORT ON GEOLOGICAL SURVEY AND DRILLING, BY J. L. MACLEOD, 1980. 68 PAGES; 7 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION; GEOLOGICAL; STRUCTURAL; ISOPACHS); DRILL HOLE LOGS; DRILL HOLE SECTIONS

11E/09A 40-B-80(02)

POTASH, ADDINGTON FORKS, ANTIGONISH COUNTY, NOVA SCOTIA. CUVIER MINES LIMITED. REPORT ON DRILLING, BY D. L. BLACK, 1981. 15 PAGES; 1 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION); DRILL HOLE LOGS

11E/10A 07-M-19(01)

BASE METALS, NEW GLASGOW, PICTOU COUNTY, NOVA SCOTIA. NORANDA EXPLORATION COMPANY LIMITED. REPORT ON SOIL GEOCHEMICAL SURVEY, BY G. GRAVES, 1981. 4 PAGES; 6 MAP(S) (PROPERTY LOCATION; GEOLOGICAL; SOIL GEOCHEMICAL)

11E/10A 07-M-19(02)

BASE METALS, NEW GLASGOW, PICTOU COUNTY, NOVA SCOTIA. NORANDA EXPLORATION COMPANY LIMITED. REPORT ON SOIL AND ROCK GEOCHEMICAL SURVEYS AND TRENCHING, BY G. GRAVES, 1982. 5 PAGES; 4 MAP(S) (SOIL GEOCHEMICAL); SOIL PROFILES; CROSS SECTIONS

11E/13A 13-E-33(01)

COPPER, PUGWASH, CUMBERLAND COUNTY, NOVA SCOTIA. ESSO RESOURCES CANADA LIMITED. REPORT ON GEOLOGY, PROSPECTING, SOIL GEOCHEMICAL, IP AND SP SURVEYS AND DRILLING, BY J. R. O'SULLIVAN, 1981. 298 PAGES; 10 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION; METALLIC MINERAL LOCATION; GEOLOGICAL; SOIL GEOCHEMICAL; I P LINES LOCATION; S P LINES LOCATION); PSEUDO SECTIONS; S P PROFILES; DRILL HOLE SECTIONS; DRILL HOLE LOGS

11E/13B 13-E-63(01)

COPPER, ROCKLEY, CUMBERLAND COUNTY, NOVA SCOTIA. ESSO RESOURCES CANADA LIMITED. REPORT ON DRILLING, BY J. O'SULLIVAN, 1983. 9 PAGES; 2 MAP(S) (DRILL HOLE LOCATION; PROPERTY LOCATION); DRILL HOLE LOGS

11F/04A 21-G-61(01)

GOLD, OFFSHORE COUNTRY HARBOUR, GUYSBOROUGH COUNTY, NOVA SCOTIA. J. E. DAWE AND C. SCHAFER (FOR F. HANSEN, T. D. COUGHLAN AND SEABRIGHT RESOURCES INCORPORATED). REPORT ON GEOLOGY, ROCK AND MARINE SEDIMENT GEOCHEMICAL SURVEYS AND SEISMIC INTERPRETATIONS, BY T. D. COUGHLAN, J. E. DAWE, C. SCHAFER, 1981. 324 PAGES; 7 MAP(S) (MARINE SEDIMENT SAMPLE LOCATION; PROPERTY LOCATION; BATHYMETRIC; MARINE SEDIMENT TYPE; FACIES; MARINE SEDIMENT GEOCHEMICAL); SEISMIC PROFILES

11F/04C 21-G-57(02)

GOLD, COUNTRY HARBOUR, GUYSBOROUGH COUNTY, NOVA SCOTIA. PARAGON EXPLORATIONS LIMITED AND SANDER GEOPHYSICS LIMITED (FOR M. E. X. EXPLORATIONS LIMITED). REPORT ON GEOLOGICAL, SOIL AND ROCK GEOCHEMICAL SURVEYS, BIOGEOCHEMICAL SURVEY AND AIRBORNE MAGNETIC SURVEY, BY E. HARRINGTON, G. W. SANDER, W. R. ARCHER, 1981. 40 PAGES; 6 MAP(S) (PROPERTY LOCATION; GEOLOGICAL; BIOGEOCHEMICAL; SOIL GEOCHEMICAL; MAGNETIC, AIRBORNE)

11F/04C 21-G-64(01)

GOLD, INDIAN RIVER, GUYSBOROUGH COUNTY, NOVA SCOTIA. PAN EAST RESOURCES INCORPORATED AND SANDER GEOPHYSICS LIMITED (FOR PAN EAST RESOURCES INCORPORATED). REPORT ON GEOLOGY, BIOGEOCHEMICAL SURVEY, STREAM SEDIMENT GEOCHEMICAL SURVEY, GROUND VLF, AIRBORNE VLF AND AIRBORNE MAGNETIC SURVEYS 1982. 16 PAGES; 5 MAP(S) (PROPERTY LOCATION; STREAM SEDIMENT SAMPLE LOCATION; BIOGEOCHEMICAL; MAGNETIC, AIRBORNE; V L F, AIRBORNE; V L F, GROUND)

11F/04D 21-G-22(06)

GOLD, ISAACS HARBOUR, GUYSBOROUGH COUNTY, NOVA SCOTIA. A. M. BARRETT. REPORT ON THE POTENTIAL OF OFFSHORE PLACER GOLD DEPOSITS, BY A. M. BARRETT, 1981. 5 PAGES; 3 MAP(S) (PROPERTY LOCATION; MARINE SEDIMENT SAMPLE LOCATION)

11F/05A 51-G-41(01)

TIN, SALMON RIVER, GUYSBOROUGH COUNTY, NOVA SCOTIA. ESSO RESOURCES CANADA LIMITED. REPORT ON GEOLOGICAL, STREAM SEDIMENT AND TILL HEAVY MINERALS GEOCHEMICAL SURVEYS, BY J. L. MACLEOD, 1982. 29 PAGES; 4 MAP(S) (PROPERTY LOCATION; ROCK SAMPLE LOCATION; GEOLOGICAL; HEAVY MINERALS GEOCHEMICAL; TILL GEOCHEMICAL)

11F/05B 21-G-07(13)

GOLD, COUNTRY HARBOUR, GUYSBOROUGH COUNTY, NOVA SCOTIA. PARAGON EXPLORATIONS LIMITED AND SANDER GEOPHYSICS LIMITED (FOR PARAGON EXPLORATIONS LIMITED). REPORT ON GEOLOGICAL, SOIL AND ROCK GEOCHEMICAL SURVEYS, BIOGEOCHEMICAL AND AIRBORNE MAGNETIC SURVEYS AND DRILLING, BY E. HARRINGTON, B. KELLY, G. W. SANDER, W. R. ARCHER, 1981. 205 PAGES; 8 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION; ROCK SAMPLE LOCATION; GEOLOGICAL; ROCK GEOCHEMICAL; BIOGEOCHEMICAL; SOIL GEOCHEMICAL; MAGNETIC, AIRBORNE; MINE SURFACE PLANS; MINE LEVEL PLANS); DRILL HOLE LOGS

11F/05B 21-G-07(14)

GOLD, COUNTRY HARBOUR, GUYSBOROUGH COUNTY, NOVA SCOTIA. PARAGON EXPLORATIONS LIMITED. REPORT ON GEOLOGICAL, SOIL GEOCHEMICAL AND BIOGEOCHEMICAL SURVEYS, BY E. HARRINGTON, 1981. 23 PAGES; 6 MAP(S) (PROPERTY LOCATION; GEOLOGICAL; BIOGEOCHEMICAL; SOIL GEOCHEMICAL)

11F/05B 21-G-07(15)

GOLD, COUNTRY HARBOUR, GUYSBOROUGH COUNTY, NOVA SCOTIA. NORTHUMBERLAND MINES LIMITED AND SANDER GEOPHYSICS LIMITED (FOR NORTHUMBERLAND MINES LIMITED AND PARAGON EXPLORATIONS LIMITED). REPORT ON GEOLOGICAL, SOIL, ROCK, HEAVY MINERALS AND STREAM SEDIMENT GEOCHEMICAL SURVEYS, AIRBORNE MAGNETIC AND AIRBORNE VLF SURVEYS, BY E. HARRINGTON, W. R. ARCHER, H. J. BROOME, 1981. 45 PAGES; 9 MAP(S) (PROPERTY LOCATION; HEAVY MINERALS SAMPLE LOCATION; ROCK SAMPLE LOCATION; SOIL SAMPLE LOCATION; STREAM SEDIMENT SAMPLE LOCATION; MAGNETIC, AIRBORNE; V L F, AIRBORNE; GEOLOGICAL)

11F/05B 21-G-13(14)

GOLD, FOREST HILL, GUYSBOROUGH COUNTY, NOVA SCOTIA. ECOLOGICAL AND RESOURCES CONSULTANTS LIMITED (FOR SEABRIGHT RESOURCES INCORPORATED). REPORT ON PHOTOGEOLOGY, TAILINGS SAMPLING AND PROPOSED EXPLORATION RECOMMENDATIONS, BY W. E. HALE, 1981. 9 PAGES; 4 MAP(S) (PROPERTY LOCATION; GEOLOGICAL)

11F/05B 21-G-13(15)

GOLD, FOREST HILL, GUYSBOROUGH COUNTY, NOVA SCOTIA. J. E. RIDDELL (FOR M. RIDDELL AND INTERNATIONAL GEOCHEMICAL ASSOCIATES). REPORT ON MINERAL DRESSING TESTS, ROCK GEOCHEMISTRY AND GROUND MAGNETIC SURVEY, BY J. E. RIDDELL, 1981. 80 PAGES; 6 MAP(S) (DRILL HOLE LOCATION; ROCK SAMPLE LOCATION; TOPOGRAPHIC; GEOLOGICAL; MINE PLANS; MAGNETIC, GROUND); GEOCHEMICAL PROFILES

11F/05B 21-G-13(16)

GOLD, FOREST HILL, GUYSBOROUGH COUNTY, NOVA SCOTIA. ECOLOGICAL AND RESOURCES CONSULTANTS LIMITED (FOR SEABRIGHT RESOURCES INCORPORATED AND K. TEASDALE). REPORT ON GEOLOGICAL SURVEY, BY W. E. HALE, 1981. 12 PAGES; 3 MAP(S) (PROPERTY LOCATION; GEOLOGICAL)

11F/06A 07-G-59(05)

BASE METALS, HAZEL HILL, GUYSBOROUGH COUNTY, NOVA SCOTIA. SULPETRO MINERALS LIMITED. REPORT ON DRILLING, BY W. P. BINNEY, 1981. 8 PAGES; 1 MAP(S) (DRILL HOLE LOCATION); DRILL HOLE LOGS; DRILL HOLE SECTIONS

11F/06A 51-G-03(01)

TIN, CANSO, GUYSBOROUGH COUNTY, NOVA SCOTIA. ESSO RESOURCES CANADA LIMITED. REPORT ON GEOLOGICAL, STREAM SEDIMENT AND TILL HEAVY MINERALS GEOCHEMICAL SURVEYS, BY J. L. MACLEOD, 1981. 31 PAGES; 7 MAP(S) (PROPERTY LOCATION; ROCK SAMPLE LOCATION; GEOLOGICAL; HEAVY MINERALS GEOCHEMICAL)

11F/09C 07-O-25(09)

BASE METALS, STIRLING, RICHMOND COUNTY, NOVA SCOTIA. AMAX MINERALS EXPLORATION. REPORT ON MINING HISTORY, GEOLOGICAL, ROCK, SOIL AND STREAM SEDIMENT GEOCHEMICAL SURVEYS AND DRILLING, BY G. COVEY, 1981. 61 PAGES; 11 MAP(S) (SOIL GEOCHEMICAL; SOIL SAMPLE LOCATION; PROPERTY LOCATION; GEOLOGICAL; DRILL HOLE LOCATION; METALLIC MINERAL LOCATION; STREAM SEDIMENT SAMPLE LOCATION); DRILL HOLE LOGS

11F/09C 07-O-25(10)

BASE METALS, STIRLING, RICHMOND COUNTY, NOVA SCOTIA. AMAX MINERALS EXPLORATION AND MERTENS AND MACNEIL (FOR AMAX MINERALS EXPLORATION).
REPORT ON GROUND MAGNETIC, IP AND RESISTIVITY SURVEYS, BY A. H. WATTS, 1982. 17 PAGES; 3 MAP(S) (RESISTIVITY; MAGNETIC, GROUND; I P); I P PROFILES; PSEUDO SECTIONS

11F/09C 07-O-69(01)

BASE METALS, FRAMBOISE, RICHMOND COUNTY, NOVA SCOTIA. ST. JOSEPH EXPLORATIONS LIMITED. REPORT ON SOIL GEOCHEMICAL, GROUND EM AND GROUND MAGNETIC SURVEYS, BY P.D. MCCULLOCH, 1977. 9 PAGES; 5 MAP(S) (DRILL HOLE LOCATION; SOIL GEOCHEMICAL; E M, GROUND; MAGNETIC, GROUND)

11F/09C 07-O-69(02)

BASE METALS, FRAMBOISE, RICHMOND COUNTY, NOVA SCOTIA. ST. JOSEPH EXPLORATIONS LIMITED. REPORT ON GROUND EM SURVEY, BY P. D. MCCULLOCH, 1977. 5 PAGES; 1 MAP(S) (E M, GROUND)

11F/09C 07-O-69(03)

BASE METALS, FRAMBOISE, RICHMOND COUNTY, NOVA SCOTIA. ST. JOSEPH EXPLORATIONS LIMITED. REPORT ON GROUND EM SURVEY, BY P. D. MCCULLOCH, 1977. 5 PAGES; 1 MAP(S) (E M, GROUND)

11F/10A 07-O-67(01)

BASE METALS, PORT MICHAUD, RICHMOND COUNTY, NOVA SCOTIA. C. MILLER AND M. ZENTILLI (FOR C. MILLER). REPORT ON GEOLOGICAL AND ROCK GEOCHEMICAL SURVEYS AND THIN SECTION MICROSCOPY, BY C. MILLER, M. ZENTILLI, 1982. 26 PAGES; 2 MAP(S) (PROPERTY LOCATION; ROCK SAMPLE LOCATION; GEOLOGICAL); STRATIGRAPHIC COLUMNS; PHOTOGRAPHS; PHOTOMICROGRAPHS

11F/10A 07-O-68(01)

BASE METALS, LOWER L'ARDOISE, RICHMOND COUNTY, NOVA SCOTIA. ST. JOSEPH EXPLORATIONS LIMITED. REPORT ON GROUND EM SURVEY, BY P. D. MCCULLOCH, 1977. 5 PAGES; 1 MAP(S) (E M, GROUND)

11F/10C 07-O-64(01)

BASE METALS, OBAN, RICHMOND COUNTY, NOVA SCOTIA. DUVAL INTERNATIONAL CORPORATION. REPORT ON GEOLOGICAL, SOIL AND ROCK GEOCHEMICAL SURVEYS, GROUND EM AND GROUND MAGNETIC SURVEYS, BY P. HIBBINS, 1981. 15 PAGES; 6 MAP(S) (PROPERTY LOCATION; GEOLOGICAL; SOIL GEOCHEMICAL; MAGNETIC, GROUND); E M PROFILES

11F/10C 07-O-64(02)

BASE METALS, OBAN, RICHMOND COUNTY, NOVA SCOTIA. DUVAL INTERNATIONAL CORPORATION. REPORT ON SOIL GEOCHEMICAL, GROUND RADIOMETRIC AND GROUND EM SURVEYS, BY P. HIBBINS, 1981. 11 PAGES; 3 MAP(S) (SOIL SAMPLE LOCATION; SOIL GEOCHEMICAL; RADIOMETRIC, GROUND); E M PROFILES

11F/10C 42-O-21(03)

SALT, ST PETERS, RICHMOND COUNTY, NOVA SCOTIA. DOMTAR LIMITED. DRILLHOLE LOGS MISSING FROM NSDME ASSESSMENT REPORT 11F/10C 42-O-21(01), BY T. E. ROWBOTTOM, C. RENE, 1969. 106 PAGES; 1 MAP(S) (GRAVITY, GROUND); CROSS SECTIONS

11F/10D 07-O-63(03)

BASE METALS, ST. ESPRIT, RICHMOND COUNTY, NOVA SCOTIA. ST. JOSEPH EXPLORATIONS LIMITED. REPORT ON GROUND EM SURVEY, BY P. D. MCCULLOCH, 1977. 6 PAGES; 1 MAP(S) (E M, GROUND)

11F/11C 42-J-68(05)

SALT, MCINTYRE LAKE, INVERNESS COUNTY, NOVA SCOTIA. KENTING EXPLORATION SERVICES LIMITED (FOR HOME OIL COMPANY LIMITED). REPORT ON SEISMIC SURVEY, BY K. B. S. BURKE, 1977. 23 PAGES; 1 MAP(S) (PROPERTY LOCATION; SEISMIC LINES LOCATION; DRILL HOLE LOCATION); CROSS SECTIONS

11F/11C 42-J-68(06)

SALT, MCINTYRE LAKE, INVERNESS COUNTY, NOVA SCOTIA. KENTING EXPLORATION SERVICES LIMITED (FOR HOME OIL COMPANY LIMITED). REPORT ON GROUND GRAVITY SURVEY, BY D. M. DANYLUK, 1977. 7 PAGES; 2 MAP(S) (PROPERTY LOCATION; GRAVITY, GROUND)

11F/11C 42-J-68(07)

SALT, MCINTYRE LAKE, INVERNESS COUNTY, NOVA SCOTIA. HOME OIL COMPANY LIMITED (FOR HOME OIL COMPANY LIMITED, MURPHY OIL COMPANY LIMITED AND NORTH CANADIAN OILS LIMITED). REPORT ON DRILLING AND A COMPILATION OF GEOLOGICAL AND GRAVITY DATA 1978. 57 PAGES; 7 MAP(S) (DRILL HOLE LOCATION; PROPERTY LOCATION; GEOLOGICAL; GRAVITY, GROUND; SUBSURFACE GEOLOGICAL; ISOPACHS); DRILL HOLE SECTIONS; CROSS SECTIONS; GAMMA RAY LOGS; NEUTRON LOGS; CALIPER LOGS; DENSITY LOGS; DRILL HOLE LOGS

11F/11C 42-O-27(01)

POTASH, WEST BAY, RICHMOND COUNTY, NOVA SCOTIA. NORANDA EXPLORATION COMPANY LIMITED. REPORT ON GEOLOGICAL COMPILATION, GROUND GRAVITY SURVEY AND DRILLING, BY P. COPPER, 1981. 117 PAGES; 4 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION; GEOLOGICAL; GRAVITY, GROUND); GAMMA RAY LOGS; CALIPER LOGS; DENSITY LOGS; STRATIGRAPHIC COLUMNS; DRILL HOLE LOGS

11F/11D 40-O-27(02)

POTASH, WEST BAY, RICHMOND COUNTY, NOVA SCOTIA. NORANDA EXPLORATION COMPANY LIMITED. AIRBORNE MAGNETIC MAP, BY NORANDA EXPL C L, 1980. 1 MAP(S) (MAGNETIC, AIRBORNE)

11F/12B 40-B-38(01)

POTASH, ST ANDREWS, ANTIGONISH COUNTY, NOVA SCOTIA. CUVIER MINES LIMITED AND GEOBARR LIMITED (FOR CUVIER MINES LIMITED). REPORT ON GROUND GRAVITY SURVEY, BY D. L. BLACK, 1981. 5 PAGES; 3 MAP(S) (PROPERTY LOCATION; GRAVITY LINES LOCATION; GRAVITY, GROUND)

11F/14A 40-O-27(01)

POTASH, WEST BAY, RICHMOND COUNTY, NOVA SCOTIA. AGER, BERRETTA AND ELLIS INCORPORATED (FOR CHEVRON STANDARD LIMITED). REPORT ON GROUND AND LAKE GRAVITY SURVEYS, BY M.JOHNSON, 1982. 27 PAGES; 9 MAP(S) (PROPERTY LOCATION; GRAVITY LINES LOCATION; GRAVITY, GROUND); GRAVITY PROFILES

11F/14D 07-J-87(01)

BASE METALS, BLUES BROOK, INVERNESS COUNTY, NOVA SCOTIA. LACANA MINING CORPORATION. REPORT ON GEOLOGICAL, SOIL, STREAM SEDIMENT AND ROCK GEOCHEMICAL SURVEYS, BY B. E. MACNABB, 1980. 51 PAGES; 10 MAP(S) (PROPERTY LOCATION; STREAM SEDIMENT SAMPLE LOCATION; ROCK SAMPLE LOCATION; GEOLOGICAL; STREAM SEDIMENT GEOCHEMICAL; SOIL GEOCHEMICAL)

11F/14D 07-J-87(02)

BASE METALS, BLUES BROOK, INVERNESS COUNTY, NOVA SCOTIA. LACANA MINING CORPORATION. REPORT ON DRILLING, BY B. E. MACNABB, 1981. 20 PAGES; 2 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION; SOIL GEOCHEMICAL; STREAM SEDIMENT GEOCHEMICAL); DRILL HOLE LOGS; DRILL HOLE SECTIONS

11F/14D 40-J-59(02)

POTASH, WHYCOCOMAGH, INVERNESS COUNTY, NOVA SCOTIA. NORANDA EXPLORATION COMPANY LIMITED. BOUGER GRAVITY DATA MAP AND PROPERTY LOCATION MAP MISSING FROM NSDME ASSESSMENT REPORT 11F/14D 40-J-59(01), BY NORANDA EXPL C L, 1977. 2 MAP(S) (PROPERTY LOCATION; GRAVITY, GROUND)

11F/15A 06-O-65(01)

BARITE, PINE BROOK, RICHMOND COUNTY, NOVA SCOTIA. A. M. BARRETT. REPORT ON GEOLOGY, TRENCHING AND DRILLING AND ASSESSMENT OF THE ECONOMIC FEASIBILITY OF DEVELOPING THE DEPOSIT, BY A. M. BARRETT, 1981. 25 PAGES; 4 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION; TRENCH LOCATION; GEOLOGICAL); DRILL HOLE LOGS

11F/15B 40-J-36(01)

POTASH, MALAGAWATCH, INVERNESS COUNTY, NOVA SCOTIA. GRANT GEOPHYSICAL LIMITED (FOR CHEVRON STANDARD LIMITED). REPORT ON VIBROSEIS REFLECTION SEISMIC SURVEY, BY W. J. MCCORMACK, 1981. 13 PAGES; 1 MAP(S) (SEISMIC)

11F/15B 40-J-36(02)

POTASH, MALAGAWATCH, INVERNESS COUNTY, NOVA SCOTIA. CHEVRON STANDARD LIMITED. COMPILATION REPORT ON GEOLOGY, STRATIGRAPHY, EXPLORATION HISTORY, GROUND GRAVITY, GROUND AND LAKE SEISMIC SURVEYS AND DRILLING, BY L. DEKKER, 1982. 780 PAGES; 18 MAP(S) (GRAVITY, GROUND; SEISMIC, LAKE; PROPERTY LOCATION; DRILL HOLE LOCATION; CROSS SECTION LOCATION; GEOLOGICAL; MINERAL POTENTIAL; SUBSURFACE TOPOGRAPHIC; SEISMIC); GAMMA RAY LOGS; CALIPER LOGS; NEUTRON LOGS; DENSITY LOGS; SONIC LOGS; DRILL CORE ANALYSES TABLES; GEOCHEMICAL PROFILES; CORRELATION CHARTS; HISTOGRAMS; CROSS SECTIONS; STRATIGRAPHIC COLUMNS; DRILL HOLE LOGS; DRILL HOLE GEOCHEMICAL PROFILES; PHOTOGRAPHS; CORRELATION SECTIONS

11F/15B 40-O-66(01)

POTASH, BRAS D'OR LAKE, RICHMOND COUNTY, NOVA SCOTIA. FAIRFIELD AQUATRONICS LIMITED (FOR CHEVRON STANDARD LIMITED). REPORT ON LAKE REFLECTION SEISMIC SURVEY, BY W. J. MCCORMACK, 1981. 19 PAGES; 1 MAP(S) (SEISMIC LINES LOCATION); SEISMIC PROFILES

11F/16A 07-C-106(01)

BASE METALS, HARDY LAKE, CAPE BRETON COUNTY, NOVA SCOTIA. ST. JOSEPH EXPLORATIONS LIMITED. REPORT ON SOIL GEOCHEMICAL, GROUND EM, GROUND VLF AND GROUND MAGNETIC SURVEYS, BY P. D. MCCULLOCH, 1977. 8 PAGES; 11 MAP(S) (SOIL GEOCHEMICAL; E M, GROUND; V L F, GROUND; MAGNETIC, GROUND)

11F/16A 07-C-106(02)

BASE METALS, HARDY LAKE, CAPE BRETON COUNTY, NOVA SCOTIA. ST. JOSEPH EXPLORATIONS LIMITED. REPORT ON DRILLING, BY A. L. SANGSTER, 1977. 6 PAGES; DRILL HOLE SECTIONS; DRILL HOLE LOGS

11F/16A 07-C-107(01)

BASE METALS, GULL COVE, CAPE BRETON COUNTY, NOVA SCOTIA. ST. JOSEPH EXPLORATIONS LIMITED. REPORT ON SOIL GEOCHEMICAL AND GROUND EM SURVEYS, BY P. D. MCCULLOCH, 1977. 6 PAGES; 6 MAP(S) (E M, GROUND; SOIL GEOCHEMICAL)

11F/16B 07-C-105(01)

BASE METALS, GRAND MIRA SOUTH, CAPE BRETON COUNTY, NOVA SCOTIA. ST. JOSEPH EXPLORATIONS LIMITED. REPORT ON SOIL GEOCHEMICAL, GROUND EM AND GROUND MAGNETIC SURVEYS, BY P. D. MCCULLOCH, 1977. 8 PAGES; 7 MAP(S) (SOIL GEOCHEMICAL; E M, GROUND; MAGNETIC, GROUND)

11F/16B 07-C-108(01)

BASE METALS, MACDONALD LAKE, CAPE BRETON COUNTY, NOVA SCOTIA. ST. JOSEPH EXPLORATIONS LIMITED. REPORT ON GROUND EM SURVEY, BY P. D. MCCULLOCH, 1977. 5 PAGES; 1 MAP(S) (E M, GROUND)

11F/16B 07-C-97(01)

BASE METALS, UPPER GRAND MIRA, CAPE BRETON COUNTY, NOVA SCOTIA. ST. JOSEPH EXPLORATIONS LIMITED. REPORT ON SOIL GEOCHEMICAL, GROUND EM, GROUND VLF AND GROUND MAGNETIC SURVEYS, BY P. D. MCCULLOCH, 1977. 6 PAGES; 6 MAP(S) (E M, GROUND; MAGNETIC, GROUND; SOIL GEOCHEMICAL)

11F/16B 27-C-04(02)

LEAD, BIG BARREN, CAPE BRETON COUNTY, NOVA SCOTIA. AMAX EXPLORATION INCORPORATED. DRILL HOLE LOGS, BY AMAX EXPL INC, 1974. 13 PAGES; 1 MAP(S) (GEOLOGICAL; DRILL HOLE LOCATION)

11F/16C 07-C-102(02)

BASE METALS, GILLIS MOUNTAIN, CAPE BRETON COUNTY, NOVA SCOTIA. NORANDA EXPLORATION COMPANY LIMITED. REPORT ON PROSPECTING, SOIL AND ROCK GEOCHEMICAL SURVEYS AND IP SURVEYS, BY G. GRAVES, 1981. 6 PAGES; 14 MAP(S) (PROPERTY LOCATION; I P LINES LOCATION; DRILL HOLE LOCATION; ROCK SAMPLE LOCATION; GEOLOGICAL; SOIL GEOCHEMICAL); PSEUDO SECTIONS; TOPOGRAPHIC PROFILES

11F/16C 07-C-104(01)

BASE METALS, FRENCH VILLAGE LAKE, CAPE BRETON COUNTY, NOVA SCOTIA. ST. JOSEPH EXPLORATIONS LIMITED. REPORT ON GEOLOGY, ROCK AND SOIL GEOCHEMICAL SURVEYS AND GROUND EM AND GROUND VLF SURVEYS, BY P. D. MCCULLOCH, 1976. 21 PAGES; 6 MAP(S) (PROPERTY LOCATION; SOIL GEOCHEMICAL; E M, GROUND); STRATIGRAPHIC CHARTS

11F/16D 07-C-31(09)

BASE METALS, DEEP COVE, CAPE BRETON COUNTY, NOVA SCOTIA. GEOTECH SURVEYS LIMITED AND AMAX MINERALS EXPLORATION (FOR AMAX MINERALS EXPLORATION AND LOUISBOURG PROPERTY HOLDINGS). REPORT ON GEOLOGICAL AND STREAM SEDIMENT GEOCHEMICAL SURVEYS, BY S. SEARS, 1981. 7 PAGES; 4 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION; GEOLOGICAL; MAGNETIC, AIRBORNE)

11F/16D 07-C-31(10)

BASE METALS, DEEP COVE, CAPE BRETON COUNTY, NOVA SCOTIA. GEOTECH SURVEYS LIMITED (FOR AMAX MINERALS EXPLORATION AND LOUISBOURG PROPERTY HOLDINGS). REPORT ON GEOLOGICAL SURVEY, BY W. B. ERVINE, 1981. 41 PAGES; 4 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION; GEOLOGICAL; MAGNETIC, AIRBORNE); STRESS DIAGRAMS; CROSS SECTIONS; STRUCTURAL DATA GRAPHS

11F/16D 07-C-40(09)

BASE METALS, FRENCH ROAD, CAPE BRETON COUNTY, NOVA SCOTIA. D. FORGERON (FOR J. E. RIDDELL). REPORT ON GEOLOGICAL, SOIL GEOCHEMICAL, TELLURIC, GROUND EM AND GROUND MAGNETIC SURVEYS, BY D. FORGERON, 1981. 10 PAGES; 3 MAP(S) (PROPERTY LOCATION; GEOLOGICAL; SOIL GEOCHEMICAL; MAGNETIC, GROUND); TELLURIC PROFILES; E M PROFILES

11K/02B 21-Q-47(01)

GOLD, LOWER WASHABUCK, VICTORIA COUNTY, NOVA SCOTIA. J. E. DAWE (FOR A. THOMPSON). REPORT ON GEOLOGICAL AND ROCK GEOCHEMICAL SURVEYS, BY J. E. DAWE, 1981. 17 PAGES; 2 MAP(S) (PROPERTY LOCATION; ROCK SAMPLE LOCATION); CROSS SECTIONS

11K/02C 07-Q-12(03)

BASE METALS, MIDDLE RIVER, VICTORIA COUNTY, NOVA SCOTIA. ESSO RESOURCES CANADA LIMITED. REPORT ON GEOLOGICAL AND SOIL GEOCHEMICAL SURVEYS, BY J. L. MACLEOD, 1981. 20 PAGES; 18 MAP(S) (PROPERTY LOCATION; GEOLOGICAL; SOIL GEOCHEMICAL)

11K/02C 07-Q-25(01)

BASE METALS, BADDECK RIVER, VICTORIA COUNTY, NOVA SCOTIA. ST. JOSEPH EXPLORATIONS LIMITED. REPORT ON GEOLOGY AND SOIL GEOCHEMICAL SURVEY, BY P. D. MCCULLOCH, 1976. 9 PAGES

11K/02C 21-Q-12(13)

GOLD, MIDDLE RIVER, VICTORIA COUNTY, NOVA SCOTIA. GEOSEARCH CONSULTANTS LIMITED (FOR DOME EXPLORATION (CANADA) LIMITED). REPORT ON GROUND MAGNETIC SURVEY, BY J. A. WOODARD, 1981. 4 PAGES; 5 MAP(S) (MAGNETIC, GROUND)

11K/03B 06-J-88(01)

BARITE, MABOU MINES, INVERNESS COUNTY, NOVA SCOTIA. A. M. BARRETT. REPORT ON GEOLOGICAL SURVEY, DRILL CORE GEOCHEMISTRY AND TRENCHING, BY A. M. BARRETT, 1981. 6 PAGES; 2 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION; ORE RESERVES)

11K/03C 06-J-89(01)

BARITE, MILL BROOK, INVERNESS COUNTY, NOVA SCOTIA. A. M. BARRETT. REPORT ON GEOLOGICAL SURVEY, DRILL CORE GEOCHEMISTRY AND TRENCHING, BY A. M. BARRETT, 1981. 6 PAGES; 2 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION; GEOLOGICAL)

11K/03C 07-J-42(04)

BASE METALS, MABOU HIGHLANDS, INVERNESS COUNTY, NOVA SCOTIA. NORANDA EXPLORATION COMPANY LIMITED. REPORT ON DRILLING, BY G. GRAVES, 1981. 14 PAGES; 2 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION); DRILL HOLE SECTIONS; DRILL HOLE LOGS

11K/03D 19-J-56(01)

FULLERS EARTH, SCOTSVILLE, INVERNESS COUNTY, NOVA SCOTIA. A. M. BARRETT (FOR COASTAL RESOURCES LIMITED). REPORT ON GEOLOGY, ORE RESERVES AND EVALUATION OF WATER ABSORBENCY OF CLAY, BY A. M. BARRETT, 1981. 11 PAGES; 5 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION; TOPOGRAPHIC; GEOLOGICAL); CROSS SECTIONS

11K/07B 07-J-86(03)

BASE METALS, RYAN BROOK, INVERNESS COUNTY, NOVA SCOTIA. DUVAL INTERNATIONAL CORPORATION. REPORT ON DRILLING, BY P. HIBBINS, 1981. 8 PAGES; 2 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION); DRILL HOLE LOGS; GEOCHEMICAL PROFILES

11K/07B 21-Q-48(01)

GOLD, BIG BARREN, VICTORIA COUNTY, NOVA SCOTIA. JAMES E. TILSLEY AND ASSOCIATES LIMITED AND SHERRITT GORDON MINES LIMITED (FOR L. A. YORK). REPORT ON PROSPECTING, GEOLOGY, PIT-DIGGING, BIOGEOCHEMICAL SURVEY AND STREAM SEDIMENT GEOCHEMICAL SURVEY OF PRE-GLACIAL ALLUVIUM, BY J. E. TILSLEY, 1981. 18 PAGES; 2 MAP(S) (BIOGEOCHEMICAL; HEAVY MINERALS GEOCHEMICAL; PIT LOCATION; GEOLOGICAL)

11K/10B 07-J-87(01)

BASE METALS, TURNER BROOK, INVERNESS COUNTY, NOVA SCOTIA. M. C. BLANCHARD. REPORT ON GEOLOGICAL AND ROCK GEOCHEMICAL SURVEYS, BY M. C. BLANCHARD, 1981. 15 PAGES; 3 MAP(S) (PROPERTY LOCATION; ROCK SAMPLE LOCATION; GEOLOGICAL)

11K/10B 07-J-87(02)

BASE METALS, TURNER BROOK, INVERNESS COUNTY, NOVA SCOTIA. M. C. BLANCHARD. REPORT ON GEOLOGICAL SURVEY, BY M. C. BLANCHARD, M. A. WILLIAMSON, 1982. 6 PAGES; 1 MAP(S) (GEOLOGICAL)

20O/16D 21-R-06(02)

GOLD, CRANBERRY HEAD, YARMOUTH COUNTY, NOVA SCOTIA. A. D. HUDGINS (FOR ATLANTIC GOLD MINES LIMITED). REPORT ON GEOLOGY AND MINING HISTORY, BY A. D. HUDGINS, 1981. 4 PAGES

20O/16D 21-R-06(03)

GOLD, CRANBERRY HEAD, YARMOUTH COUNTY, NOVA SCOTIA. A. FREW (FOR ATLANTIC GOLD MINES LIMITED). REPORT ON MINING HISTORY, GEOLOGY AND ROCK GEOCHEMISTRY, BY A. FREW, 1980. 9 PAGES; 1 MAP(S) (PROPERTY LOCATION)

20P/13C 07-R-10(04)

BASE METALS, TUSKET, YARMOUTH COUNTY, NOVA SCOTIA. GEOTERREX LIMITED (FOR KERR ADDISON MINES LIMITED). AIRBORNE MAGNETIC CONTOUR MAPS MISSING FROM NSDME ASSESSMENT REPORT 20P/13C 07-R-10(02), BY GEOTERREX L, 1977. 6 MAP(S) (MAGNETIC, AIRBORNE)

20P/13C 51-R-10(01)

TIN, TUSKET, YARMOUTH COUNTY, NOVA SCOTIA. ESSO RESOURCES CANADA LIMITED (FOR ESSO RESOURCES CANADA LIMITED, KERR ADDISON MINES LIMITED AND DOME EXPLORATION LIMITED). REPORT ON GEOLOGICAL, STREAM SEDIMENT AND TILL HEAVY MINERALS GEOCHEMICAL SURVEYS, BY J. L. MACLEOD, D. BOURQUE, 1981. 37 PAGES; 11 MAP(S) (PROPERTY LOCATION; ROCK SAMPLE LOCATION; TILL SAMPLE LOCATION; STREAM SEDIMENT SAMPLE LOCATION; HEAVY MINERALS SAMPLE LOCATION; GEOLOGICAL; HEAVY MINERALS GEOCHEMICAL; STREAM SEDIMENT GEOCHEMICAL; TILL GEOCHEMICAL)

20P/14C 51-P-13(01)

TIN, DECEPTION LAKE, SHELBURNE COUNTY, NOVA SCOTIA. PLACER DEVELOPMENT LIMITED. REPORT ON SOIL GEOCHEMICAL AND GROUND EM SURVEYS, BY C. KEECH, P. KOWALCZYK, 1982. 82 PAGES; 12 MAP(S) (PROPERTY LOCATION; SOIL GEOCHEMICAL); HISTOGRAMS; E M PROFILES

21A/02D 07-N-32(01)

BASE METALS, SALTERS LAKE, QUEENS COUNTY, NOVA SCOTIA. ST. JOSEPH EXPLORATIONS LIMITED. REPORT ON GEOLOGICAL, SOIL GEOCHEMICAL AND GROUND VLF SURVEYS, BY K. M. KRYKLYWY, 1979. 6 PAGES; 7 MAP(S) (GEOLOGICAL; SOIL SAMPLE LOCATION; SOIL GEOCHEMICAL; V L F, GROUND)

21A/02D 21-N-09(09)

GOLD, MILL VILLAGE, QUEENS COUNTY, NOVA SCOTIA. CARD LAKE MINES LIMITED, TALISMAN MINES LIMITED AND DAVID R. BELL, GEOLOGICAL SERVICES INCORPORATED (FOR W. NEILLY, CARD LAKE MINES LIMITED AND TALISMAN MINES LIMITED). REPORT ON DRILLING, BY D. R. BELL, 1981. 29 PAGES; 2 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION); DRILL HOLE LOGS; DRILL HOLE SECTIONS

21A/03C 54-P-10(01)

URANIUM, MINK LAKE, SHELBURNE COUNTY, NOVA SCOTIA. SHELL CANADA RESOURCES LIMITED. REPORT ON GEOLOGICAL, SOIL GEOCHEMICAL AND GROUND RADIOMETRIC SURVEYS, BY G. B. DICKIE, 1981. 32 PAGES; 4 MAP(S) (PROPERTY LOCATION; SOIL SAMPLE LOCATION; GEOLOGICAL; SOIL GEOCHEMICAL)

21A/04A 51-R-25(08)

TIN, EAST KEMPTVILLE, YARMOUTH COUNTY, NOVA SCOTIA. SHELL CANADA RESOURCES LIMITED. REPORT ON DRILLING, BY R. L. KOHLSMITH, B. H. WILSON, G. MACGILLIVRAY, 1981. 41 PAGES; 2 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION); DRILL HOLE LOGS; DRILL HOLE SECTIONS

21A/04A 51-R-25(09)

TIN, EAST KEMPTVILLE, YARMOUTH COUNTY, NOVA SCOTIA. SHELL CANADA RESOURCES LIMITED. REPORT ON DRILLING, BY R. L. KOHLSMITH, B. H. WILSON, 1981. 98 PAGES; 2 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION); DRILL HOLE LOGS

21A/04A 51-R-25(10)

TIN, EAST KEMPTVILLE, YARMOUTH COUNTY, NOVA SCOTIA. SHELL CANADA RESOURCES LIMITED. REPORT ON DRILLING, BY R. L. KOHLSMITH, 1981. 61 PAGES; 2 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION); DRILL HOLE LOGS; DRILL HOLE SECTIONS

21A/04A 51-R-25(11)

TIN, EAST KEMPTVILLE, YARMOUTH COUNTY, NOVA SCOTIA. SHELL CANADA RESOURCES LIMITED. REPORT ON ROCK AND TILL GEOCHEMISTRY AND OVERBURDEN DRILLING, BY J. I. LAWYER, 1981. 23 PAGES; 2 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION); DRILL HOLE LOGS

21A/04A 51-R-25(12)

TIN, EAST KEMPTVILLE, YARMOUTH COUNTY, NOVA SCOTIA. SHELL CANADA RESOURCES LIMITED. REPORT ON TILL GEOCHEMICAL SURVEY, BY P. E. SINCLAIR, 1981. 6 PAGES; 12 MAP(S) (PROPERTY LOCATION; TILL GEOCHEMICAL; TILL SAMPLE LOCATION)

21A/04A 51-R-25(13)

TIN, EAST KEMPTVILLE, YARMOUTH COUNTY, NOVA SCOTIA. SHELL CANADA RESOURCES LIMITED. REPORT ON OVERBURDEN DRILLING AND TILL GEOCHEMISTRY, BY P. E. SINCLAIR, 1981. 65 PAGES; 2 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION); DRILL HOLE LOGS

21A/04B 21-R-07(04)

GOLD, KEMPTVILLE, YARMOUTH COUNTY, NOVA SCOTIA. W. E. HALE AND ASSOCIATES (FOR BV PROPERTY MANAGEMENT LIMITED). REPORT ON THE EVALUATION OF POTENTIAL ECONOMIC MINERALS AND A PROPOSAL FOR EXPLORATION ACTIVITIES, BY W. E. HALE, 1981. 66 PAGES; 4 MAP(S) (PROPERTY LOCATION; GEOLOGICAL)

21A/04B 51-R-25(03)

TIN, EAST KEMPTVILLE, YARMOUTH COUNTY, NOVA SCMTIA. EASTERN GEOPHYSICS LIMITED (FOR SHELL CANADA RESOURCES LIMITED). REPORT ON GROUND GRAVITY SURVEY, BY P. E. SINCLAIR, 1981. 4 PAGES; 3 MAP(S) (PROPERTY LOCATION; GRAVITY LINES LOCATION); GRAVITY PROFILES

21A/04D 51-R-25(02)

TIN, EAST KEMPTVILLE, YARMOUTH COUNTY, NOVA SCOTIA. EASTERN GEOPHYSICS LIMITED AND SHELL CANADA RESOURCES LIMITED (FOR SHELL CANADA RESOURCES LIMITED). REPORT ON GROUND GRAVITY SURVEY, BY K. ROBERTSON, P. E. SINCLAIR, 1981. 3 MAP(S) (PROPERTY LOCATION; GRAVITY LINES LOCATION); GRAVITY PROFILES

21A/06A 21-N-26(06)

GOLD, WHITEBURN, QUEENS COUNTY, NOVA SCOTIA. W. A. MACPHERSON (FOR INTERNATIONAL GEOCHEMICAL ASSOCIATES LIMITED, A. THOMPSON, M. RIDDELL AND ENTREPRENEURAL MANAGEMENT LIMITED). REPORT ON GEOLOGY AND RECOMMENDED EXPLORATION PROGRAM, BY W. A. MACPHERSON, 1981. 17 PAGES; 3 MAP(S) (PROPERTY LOCATION; GEOLOGIAL)

21A/06A 21-N-26(07)

GOLD, WHITEBURN, QUEENS COUNTY, NOVA SCOTIA. R. BAKER (FOR R. BAKER AND NOVEX RESOURCE MANAGEMENT). REPORT ON GEOLOGICAL SURVEY, BY R. BAKER, 1981. 4 PAGES; 1 MAP(S) (PROPERTY LOCATION)

21A/06A 21-N-26(08)

GOLD, WHITEBURN, QUEENS COUNTY, NOVA SCOTIA. WHITEBURN PRECIOUS METALS LIMITED. REPORT ON GEOLOGICAL AND GROUND MAGNETIC SURVEYS, BY D. FORGERON, 1981. 4 PAGES; 1 MAP(S) (PROPERTY LOCATION); MAGNETIC PROFILES

21A/06B 51-F-14(01)

TIN, PESKANA LAKE, DIGBY COUNTY, NOVA SCOTIA. LACANA MINING CORPORATION. REPORT ON TILL, ROCK, STREAM SEDIMENT AND LAKE SEDIMENT GEOCHEMICAL SURVEYS, BY B. E. MACNABB, 1980. 19 PAGES; 2 MAP(S) (PROPERTY LOCATION; LAKE SEDIMENT GEOCHEMICAL; STREAM SEDIMENT GEOCHEMICAL; TILL GEOCHEMICAL)

21A/06D 51-M-06(01)

TIN, CALDEDONIA, QUEENS COUNTY, NOVA SCOTIA. SHELL CANADA RESOURCES LIMITED AND EASTERN GEOPHYSICS LIMITED (FOR SHELL CANADA RESOURCES LIMITED). REPORT ON PROSPECTING, GEOLOGICAL, TILL AND ROCK GEOCHEMICAL, AND GROUND GRAVITY SURVEYS, BY G. MACGILLIVRAY, R. L. KOHLSMITH, 1981. 14 PAGES; 13 MAP(S) (PROPERTY LOCATION; METALLIC MINERAL LOCATION; ROCK SAMPLE LOCATION; TILL SAMPLE LOCATION; GRAVITY LINES LOCATION; GEOLOGICAL; ROCK GEOCHEMICAL); GRAVITY PROFILES; CROSS SECTIONS

21A/07A 07-L-49(01)

BASE METALS, FISHER LAKE, LUNENBURG COUNTY, NOVA SCOTIA. COMINCO LIMITED. REPORT ON SOIL GEOCHEMICAL SURVEY, BY N. L. SZABO, 1981. 5 PAGES; 2 MAP(S) (PROPERTY LOCATION; SOIL GEOCHEMICAL); FREQUENCY DISTRIBUTION GRAPHS

21A/07A 07-L-50(01)

BASE METALS, HEBB LAKE, LUNENBURG COUNTY, NOVA SCOTIA. COMINCO LIMITED. REPORT ON SOIL GEOCHEMICAL SURVEY, BY N. L. SZABO, 1981. 5 PAGES; 2 MAP(S) (PROPERTY LOCATION; SOIL GEOCHEMICAL); FREQUENCY DISTRIBUTION GRAPHS

21A/07A 21-L-17(08)

GOLD, LEIPSIGATE, LUNENBURG COUNTY, NOVA SCOTIA. TRAFALGAR RESOURCE INVESTMENTS LIMITED. REPORT ON RECONNAISSANCE SURVEY, BY A. W. LOCKERBY, 1981. 3 PAGES; 2 MAP(S) (PROPERTY LOCATION)

21A/07B 07-M-30(01)

BASE METALS, ST. MARY'S BAY, QUEENS COUNTY, NOVA SCOTIA. COMINCO LIMITED. REPORT ON SOIL GEOCHEMICAL SURVEY, BY N. L. SZABO, 1981. 5 PAGES; 2 MAP(S) (PROPERTY LOCATION; SOIL GEOCHEMICAL); FREQUENCY DISTRIBUTION GRAPHS

21A/07B 07-M-31(01)

BASE METALS, MOOSEHORN LAKE, QUEENS COUNTY, NOVA SCOTIA. COMINCO LIMITED. REPORT ON SOIL GEOCHEMICAL SURVEY, BY N. L. SZABO, 1981. 5 PAGES; 2 MAP(S) (PROPERTY LOCATION; SOIL GEOCHEMICAL); FREQUENCY DISTRIBUTION GRAPHS

21A/07C 21-L-25(07)

GOLD, PLEASANT RIVER BARRENS, LUNENBURG COUNTY, NOVA SCOTIA. W. A. MACPHERSON (FOR CLAYMORE MANAGEMENT LIMITED). REPORT ON GEOLOGY AND TAILINGS SAMPLING, BY W. A. MACPHERSON, 1981. 6 PAGES; 1 MAP(S) (PROPERTY LOCATION)

21A/07C 21-L-25(08)

GOLD, PLEASANT RIVER BARRENS, LUNENBURG COUNTY, NOVA SCOTIA. R. BAKER (FOR R. BAKER AND NOVEX RESOURCE MANAGEMENT). REPORT ON GEOLOGICAL AND ROCK GEOCHEMICAL SURVEYS, BY R. BAKER, 1981. 5 PAGES; 1 MAP(S) (PROPERTY LOCATION; ROCK SAMPLE LOCATION)

21A/07C 21-N-01(23)

GOLD, BROOKFIELD, QUEENS COUNTY, NOVA SCOTIA. M. E. X. EXPLORATIONS LIMITED AND BAKERTALC INCORPORATED. REPORT ON GROUND EM SURVEY AND DRILLING, BY D. L. BLACK, 1983. 26 PAGES; 3 MAP(S) (PROPERTY LOCATION; MINE SURFACE PLANS; E M, GROUND; DRILL HOLE LOCATION); DRILL HOLE LOGS

21A/07C 21-N-01(24)

GOLD, BROOKFIELD, QUEENS COUNTY, NOVA SCOTIA. M. E. X. EXPLORATIONS LIMITED AND BAKERTALC INCORPORATED. REPORT ON GROUND EM SURVEY AND DRILLING, BY D. L. BLACK, 1983. 9 PAGES; 3 MAP(S) (PROPERTY LOCATION MINE SURFACE PLANS; E M, GROUND; DRILL HOLE LOCATION)

21A/07C 21-N-01(25)

GOLD, BROOKFIELD, QUEENS COUNTY, NOVA SCOTIA. M. E. X. EXPLORATIONS LIMITED AND BAKERTALC INCORPORATED. REPORT ON GROUND EM SURVEY, ROCK GEOCHEMISTRY, DRILLING AND TRENCHING, BY D. L. BLACK, 1983. 48 PAGES; 4 MAP(S) (PROPERTY LOCATION; E M, GROUND; DRILL HOLE LOCATION; MINE SURFACE PLANS; TRENCH LOCATION); DRILL HOLE LOGS

21A/07C 21-N-01(26)

GOLD, BROOKFIELD, QUEENS COUNTY, NOVA SCOTIA. M. E. X. EXPLORATIONS LIMITED AND BAKERTALC INCORPORATED. REPORT ON GROUND EM SURVEY AND DRILLING, BY D. L. BLACK, 1983. 9 PAGES; 3 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION; E M, GROUND; MINE SURFACE PLANS); DRILL HOLE LOGS

21A/07C 21-N-01(27)

GOLD, BROOKFIELD, QUEENS COUNTY, NOVA SCOTIA. M. E. X. EXPLORATIONS LIMITED AND BAKERTALC INCORPORATED. REPORT ON GROUND EM SURVEY, ROCK GEOCHEMISTRY AND DRILLING, BY D. L. BLACK, 1983. 13 PAGES; 3 MAP(S) (PROPERTY LOCATION; MINE SURFACE PLANS; E M, GROUND; DRILL HOLE LOCATION); DRILL HOLE LOGS

21A/07C 21-N-01(28)

GOLD, BROOKFIELD, QUEENS COUNTY, NOVA SCOTIA. M. E. X. EXPLORATIONS LIMITED AND BAKERTALC INCORPORATED. REPORT ON GROUND EM AND SP SURVEYS AND DRILLING, BY D. L. BLACK, 1983. 21 PAGES; 4 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION; E M, GROUND; S P); DRILL HOLE LOGS

21A/07C 53-M-24(01)

TUNGSTEN, WESTFIELD, QUEENS COUNTY, NOVA SCOTIA. SHELL CANADA RESOURCES LIMITED. REPORT ON GEOLOGICAL AND TILL GEOCHEMICAL SURVEYS, BY G. MACGILLIVRAY, 1981. 13 PAGES; 12 MAP(S) (PROPERTY LOCATION; GEOLOGICAL; METALLIC MINERAL LOCATION; ROCK SAMPLE LOCATION; TILL SAMPLE LOCATION; TILL GEOCHEMICAL; MINE SURFACE PLANS)

21A/07D 07-L-51(01)

BASE METALS, ROCKY LAKE, LUNENBURG COUNTY, NOVA SCOTIA. COMINCO LIMITED. REPORT ON SOIL GEOCHEMICAL SURVEY, BY N. L. SZABO, 1981. 5 PAGES; 2 MAP(S) (PROPERTY LOCATION; SOIL GEOCHEMICAL); FREQUENCY DISTRIBUTION GRAPHS

21A/07D 07-L-52(01)

BASE METALS, HUEY LAKE, LUNENBURG COUNTY, NOVA SCOTIA. COMINCO LIMITED. REPORT ON SOIL GEOCHEMICAL SURVEY, BY N. L. SZABO, 1981. 5 PAGES; 2 MAP(S) (PROPERTY LOCATION; SOIL GEOCHEMICAL); FREQUENCY DISTRIBUTION GRAPHS

21A/08B 21-L-46(01)

GOLD, OFFSHORE OVENS, LUNENBURG COUNTY, NOVA SCOTIA. A. M. BARRETT. REPORT ON MARINE SEDIMENT SAMPLING AND ASSESSMENT OF POTENTIAL PLACER GOLD DEPOSITS, BY A. M. BARRETT, 1981. 9 PAGES; 2 MAP(S) (PROPERTY LOCATION MARINE SEDIMENT SAMPLE LOCATION)

21A/08C 21-L-03(08)

GOLD, BLOCKHOUSE, LUNENBURG COUNTY, NOVA SCOTIA. W. A. MACPHERSON (FOR BLOCKHOUSE RESOURCES LIMITED). REPORT ON PROSPECTING, MINING HISTORY AND PROPOSED EXPLORATION RECOMMENDATIONS, BY A. W. LOCKERBY, W. A. MACPHERSON, 1981. 24 PAGES; 7 MAP(S) (PROPERTY LOCATION; MINE SURFACE PLANS); MINE CROSS SECTIONS

21A/09B 21-L-09(15)

GOLD, GOLD RIVER, LUNENBURG COUNTY, NOVA SCOTIA. A. D. HUDGINS (FOR ATLANTIC GOLD MINES LIMITED). REPORT ON MINING AND EXPLORATION HISTORY AND PROPOSED EXPLORATION RECOMMENDATIONS, BY A. M. FREW, 1980. 11 PAGES; 1 MAP(S) (PROPERTY LOCATION; GEOLOGICAL)

21A/09B 21-L-09(16)

GOLD, GOLD RIVER, LUNENBURG COUNTY, NOVA SCOTIA. A. D. HUDGINS (FOR ATLANTIC GOLD MINES LIMITED). REPORT ON MINING HISTORY AND PROPOSED EXPLORATION RECOMMENDATIONS, BY A. D. HUDGINS, 1981. 4 PAGES

21A/09B 51-L-11(04)

TIN, HENRY LAKE, LUNENBURG COUNTY, NOVA SCOTIA. SHELL CANADA RESOURCES LIMITED. REPORT ON GEOLOGICAL, TILL AND ROCK GEOCHEMICAL SURVEYS, BY G. MACGILLIVRAY, R. L. KOHLSMITH, 1981. 9 PAGES; 9 MAP(S) (PROPERTY LOCATION; ROCK SAMPLE LOCATION; GEOLOGICAL; TILL GEOCHEMICAL)

21A/09C 51-L-39(02)

TIN, MILLET LAKE, LUNENBURG COUNTY, NOVA SCOTIA. EASTERN GEOPHYSICS LIMITED AND SHELL CANADA RESOURCES LIMITED (FOR SHELL CANADA RESOURCES LIMITED). REPORT ON LAKE IP AND LAKE RESISTIVITY SURVEYS, BY G. MACGILLIVRAY, 1981. 8 PAGES; 5 MAP(S) (PROPERTY LOCATION; I P LINES LOCATION; I P, LAKE; RESISTIVITY, LAKE); RESISTIVITY PROFILES; I P PROFILES

21A/09C 51-L-42(02)

TIN, SNYDER POND, LUNENBURG COUNTY, NOVA SCOTIA. EASTERN GEOPHYSICS LIMITED AND SHELL CANADA RESOURCES LIMITED (FOR SHELL CANADA RESOURCES LIMITED). REPORT ON GROUND GRAVITY SURVEY, BY G. MACGILLIVRAY, 1981. 4 PAGES; 3 MAP(S) (PROPERTY LOCATION; GRAVITY LINES LOCATION); GRAVITY PROFILES; TOPOGRAPHIC PROFILES

21A/09C 54-L-19(06)

URANIUM, NEW ROSS, LUNENBURG COUNTY, NOVA SCOTIA. CAN-LAKE EXPLORATIONS LIMITED (FOR E AND B EXPLORATIONS LIMITED). REPORT ON GEOLOGICAL, SOIL, ROCK AND RADON GEOCHEMICAL SURVEYS, GROUND MAGNETIC, GROUND RADIOMETRIC AND GROUND VLF SURVEYS AND DRILLING, BY M. G. B. PALMER, 1981. 235 PAGES; 58 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION; GEOLOGICAL; SOIL GEOCHEMICAL; ROCK GEOCHEMICAL; RADON GEOCHEMICAL; MAGNETIC, AIRBORNE; MAGNETIC, GROUND; RADIOMETRIC, AIRBORNE; RADIOMETRIC, GROUND; V L F, AIRBORNE; V L F, GROUND); DRILL HOLE SECTIONS; DRILL HOLE LOGS; GAMMA RAY LOGS; SOIL PROFILES

21A/09C 54-L-34(03)

URANIUM, MIDDLE RIVER, LUNENBURG COUNTY, NOVA SCOTIA. CAN-LAKE EXPLORATIONS LIMITED (FOR E AND B EXPLORATIONS LIMITED). REPORT ON GEOLOGICAL, ROCK AND RADON GEOCHEMICAL AND GROUND RADIOMETRIC SURVEYS, BY M. G. B. PALMER, 1981. 29 PAGES; 4 MAP(S) (PROPERTY LOCATION; GEOLOGICAL; RADON GEOCHEMICAL; ROCK GEOCHEMICAL; RADIOMETRIC, GROUND)

21A/10A 07-L-36(03)

BASE METALS, UPPER NEW CORNWALL, LUNENBURG COUNTY, NOVA SCOTIA. SULPETRO MINERALS LIMITED. REPORT ON GEOLOGICAL AND SOIL GEOCHEMICAL SURVEYS, BY M. W. THOMAS, A. L. SANGSTER, 1981. 6 PAGES; 10 MAP(S) (SOIL SAMPLE LOCATION; GEOLOGICAL; SOIL GEOCHEMICAL)

21A/10B 21-L-48(01)

GOLD, HEMFORD, LUNENBURG COUNTY, NOVA SCOTIA. R. BAKER (FOR R. BAKER AND NOVEX RESOURCE MANAGEMENT). REPORT ON GEOLOGICAL AND ROCK GEOCHEMICAL SURVEYS, BY R. BAKER, 1981. 8 PAGES; 1 MAP(S) (PROPERTY LOCATION; ROCK SAMPLE LOCATION)

21A/10C 54-A-20(05)

URANIUM, DALHOUSIE EAST, ANNAPOLIS COUNTY, NOVA SCOTIA. ESSO RESOURCES CANADA LIMITED. REPORT ON SOIL, PEAT AND TILL GEOCHEMICAL SURVEYS, TRACK-ETCH AND GROUND RADIOMETRIC SURVEYS AND DRILLING, BY Y. LOWE, 1980. 209 PAGES; 12 MAP(S) (DRILL HOLE LOCATION; DRAINAGE; ALTERATION; DRILL CORE GEOCHEMICAL; SOIL GEOCHEMICAL; RADIOMETRIC, GROUND); DRILL HOLE SECTIONS; HISTOGRAMS; DRILL HOLE LOGS; GAMMA RAY LOGS

21A/10C 54-A-23(03)

URANIUM, FALKLAND RIDGE, ANNAPOLIS COUNTY, NOVA SCOTIA. SHELL CANADA RESOURCES LIMITED. REPORT ON GEOLOGICAL AND SOIL GEOCHEMICAL SURVEYS, BY G. B. DICKIE, 5, 1980. 30 PAGES; 4 MAP(S) (PROPERTY LOCATION; SOIL SAMPLE LOCATION; GEOLOGICAL; SOIL GEOCHEMICAL)

21A/10C 54-A-23(04)

URANIUM, FALKLAND RIDGE, ANNAPOLIS COUNTY, NOVA SCOTIA. CAN-LAKE EXPLORATIONS LIMITED (FOR E AND B EXPLORATIONS LIMITED). REPORT ON GEOLOGICAL, SOIL AND ROCK GEOCHEMICAL, GROUND RADIOMETRIC AND GROUND VLF SURVEYS, BY M. G. B. PALMER, 1981. 46 PAGES; 6 MAP(S) (PROPERTY LOCATION; GEOLOGICAL; SOIL GEOCHEMICAL; ROCK GEOCHEMICAL; RADIOMETRIC, GROUND; V L F, GROUND)

21A/10D 51-K-32(01)

TIN, LAKE TORMENT, KINGS COUNTY, NOVA SCOTIA. SHELL CANADA RESOURCES LIMITED. REPORT ON PROSPECTING AND GEOLOGICAL SURVEYS, BY R. L. KOHLSMITH, 1981. 10 PAGES; 5 MAP(S) (PROPERTY LOCATION; ROCK SAMPLE LOCATION; GEOLOGICAL)

21A/14A 54-A-27(01)

URANIUM, ROXBURY, ANNAPOLIS COUNTY, NOVA SCOTIA. AQUITAINE COMPANY OF CANADA LIMITED. REPORT ON GEOLOGICAL, SOIL GEOCHEMICAL AND AIRBORNE RADIOMETRIC SURVEYS, BY D. RODGERS, 1981. 12 PAGES; 4 MAP(S) (PROPERTY LOCATION; GEOLOGICAL; RADIOMETRIC LINES LOCATION)

21A/16B 54-L-37(04)

URANIUM, HARRIS LAKE, LUNENBURG COUNTY, NOVA SCOTIA. NORCEN ENERGY RESOURCES LIMITED (FOR NORCEN, CAMPBELL RES. INC., E AND B EXPLS LTD. AND ONTARIO HYDRO). REPORT ON GEOLOGY, ROCK GEOCHEMISTRY, SOIL GEOCHEMICAL AND GROUND RADIOMETRIC SURVEYS, BY T. BOJCZYSZYN, T. TURNER, 1981. 36 PAGES; 7 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION; GEOLOGICAL; SOIL GEOCHEMICAL)

21A/16B 54-L-37(05)

URANIUM, HARRIS LAKE, LUNENBURG COUNTY, NOVA SCOTIA. NORCEN ENERGY RESOURCES LIMITED AND PATERSON, GRANT AND WATSON LIMITED (FOR NORCEN ENERGY RES. LTD., CAMPBELL RES. LTD., E AND B EXPLS. LTD. AND ONTARIO HYDRO). REPORT ON GEOLOGY, IP, GROUND RESISTIVITY, GROUND MAGNETIC, AND GROUND VLF SURVEYS AND DRILLING, BY A. T. TURNER, N. R. PATERSON, 1981. 47 PAGES; 15 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION; GEOLOGICAL; I P; MAGNETIC, GROUND; RESISTIVITY; V L F, GROUND); CROSS SECTIONS; PSEUDO SECTIONS; DRILL HOLE LOGS

21H/01D 07-I-05(03)

BASE METALS, CHEVERIE, HANTS COUNTY, NOVA SCOTIA. GULF MINERALS CANADA LIMITED. REPORT ON DRILLING, BY R. T. BOYD, 1981. 116 PAGES; 3 MAP(S) (PROPERTY LOCATION; DRILL HOLE LOCATION); STRATIGRAPHIC COLUMNS; STRATIGRAPHIC CHARTS; DRILL HOLE LOGS; DRILL HOLE SECTIONS

21H/02B 54-K-20(02)

URANIUM, NORTH KINGSTON, KINGS COUNTY, NOVA SCOTIA. GETTY MINES LIMITED. REPORT ON GEOLOGY AND DRILLING MISSING FROM NSDME ASSESSMENT REPORT 21H/02B 54-K-20(01), BY R. L. COMEAU, 1978. 26 PAGES; 3 MAP(S) (PROPERTY LOCATION; STRUCTURAL); STRATIGRAPHIC CHARTS

APPENDIX II

OPEN FILE REPORTS FOR 1983

OPEN FILE REPORTS FOR 1983

536

PEATLAND INVENTORY PROGRAM 1982 (PART III), KINGS COUNTY, NOVA SCOTIA, BY A. R. ANDERSON, W. BROUGHM, 1983. 20 PAGES; 2 MAP(S) (PEAT DEPOSIT LOCATION; ISOPACHS); PEAT PROFILES

537

LEWIS LAKE DIAMOND DRILL HOLE AND ITS GOLD POTENTIAL, BY P. K. SMITH, 1982. 48 PAGES; 2 MAP(S) (STUDY AREA LOCATION; GEOLOGICAL; DRILL HOLE LOCATION); CROSS SECTIONS; STRUCTURE STEREOGRAMS; DEVIATION LOGS; GAMMA RAY LOGS; RESISTIVITY LOGS; DENSITY LOGS; CALIPER LOGS; DRILL CORE ANALYSES TABLES; HISTOGRAMS; PHOTOMICROGRAPHS; DRILL HOLE LOGS; DRILL HOLE SECTIONS

538

GEOLOGY OF MALIGNANT COVE MAP-AREA, BY L. H. KING, 1950. 28 PAGES; 1 MAP(S) (GEOLOGICAL); PHOTOGRAPHS; STRATIGRAPHIC CHARTS

539

AN INVESTIGATION TO DETERMINE THE SOURCE, IDENTITY AND PHYSICAL AND CHEMICAL PROPERTIES OF THE MIDDLETON CLAYS OF NOVA SCOTIA, BY J. P. DOWDS, 1950. 37 PAGES; 1 MAP(S) (TOPOGRAPHIC; STUDY AREA LOCATION); PHOTOGRAPHS; CROSS SECTIONS; DTA GRAPHS; CLAY ANALYSES GRAPHS; STRATIGRAPHIC COLUMNS

540

A REPORT ON THE CRUISE OF THE C.N.A.V. SACKVILLE, BY C. HILL, 1951. 5 PAGES; PHOTOGRAPHS

541

GEOLOGY OF DIGBY NECK AND LONG AND BRIER ISLANDS, DIGBY COUNTY, NOVA SCOTIA; BY E. L. LOLLIS, 1959. 120 PAGES; 14 MAP(S) (STUDY AREA LOCATION; TOPOGRAPHIC; STRUCTURAL; DRAINAGE; PLANIMETRIC; CROSS SECTION LOCATION; ROCK SAMPLE LOCATION; PEAT DEPOSIT LOCATION; GLACIAL FEATURES; INDUSTRIAL MINERAL LOCATION); PHOTOGRAPHS; COMPOSITE SECTIONS; STRATIGRAPHIC COLUMNS; STRUCTURAL DATA GRAPHS; TOPOGRAPHIC PROFILES

542

RESISTIVITY INVESTIGATIONS FOR THE VICTORIA GYPSUM COMPANY LIMITED, BY D. J. MACNEIL, 1950. 9 PAGES; 2 MAP(S) (RESISTIVITY; OVERBURDEN THICKNESS); RESISTIVITY PROFILES

543

THE GEOLOGY OF NOVA SCOTIA, BY W. C. PHINNEY, 1957. 76 PAGES; STRATIGRAPHIC CHARTS; STRATIGRAPHIC COLUMNS; CROSS SECTIONS

544

THE MISSISSIPPIAN STRATA OF THE ANTIGONISH-CAPE BRETON ISLAND AREA OF NOVA SCOTIA, BY M. D. ROSTOKER, 1957. 38 PAGES; STRATIGRAPHIC CHARTS

545

SEVERAL MAGNETIC PROFILES ACROSS THE BATESTON AND MOUNTAIN FAULTS IN THE SYDNEY COALFIELD, BY H. ZORYCHTA, 1950. 18 PAGES; 2 MAP(S) (GEOLOGICAL; MAGNETIC LINES LOCATION); MAGNETIC PROFILES; CROSS SECTIONS

546

STRUCTURAL GEOLOGY OF THE COAST NORTH OF CRYSTAL MANOR, ANTIGONISH, BY F. BARKER, J. A. BUTTERWORTH, R. N. HOLDEN, J. H. WETZEL, L. E. WIBERG, 1948. 2 PAGES; 1 MAP(S) (GEOLOGICAL)

547

GEOLOGICAL INVESTIGATION OF THE ARISAIG BEACH AREA, BY H. L. BARNES, R. F. LEE, R. B. LEONARD, 1948. 10 PAGES; BLOCK DIAGRAMS

548

REPORT ON ARISAIG SECTION, ANTIGONISH COUNTY, NOVA SCOTIA, BY R. E. TENNY, 1948. 10 PAGES; 1 MAP(S) (GEOLOGICAL; CROSS SECTION LOCATION); STRESS DIAGRAMS; CROSS SECTIONS

549

REPORT ON THE GEOLOGY OF DOCTOR'S BROOK, BY F. BARKER, 1948. 4 PAGES; 1 MAP(S) (GEOLOGICAL); CROSS SECTIONS

550

REPORT ON COPPER LAKE SURVEY, BY R. E. TENNY, 1948. 6 PAGES; 1 MAP(S) (GEOLOGICAL; SURFICIAL); DIP NEEDLE PROFILES

551

GEOLOGICAL INVESTIGATION OF THE SALMON RIVER AREA, BY R. B. LEONARD, R. F. LEE, H. L. BARNES, B. V. GOKHALE, 1948. 6 PAGES; 1 MAP(S) (GEOLOGICAL); CROSS SECTIONS

552

NOVA SCOTIA MAGNETOMETER SURVEYS, BY F. L. BARTHOLOMEW, B. V. GOKHALE, A. S. ST. GERMAIN, 1948. 9 PAGES

553

A PARTIAL ANALYSIS OF HORTON SANDSTONE FROM MORRISTOWN POINT, NOVA SCOTIA, BY I. A. BREGER, 1948. 28 PAGES; 1 MAP(S) (STRUCTURAL)

554

THE WALTON BARITE DEPOSIT, BY R. E. TENNY, 1949. 28 PAGES; 2 MAP(S) (TOPOGRAPHIC; GEOLOGICAL; MINE LEVEL PLANS); BLOCK DIAGRAMS; STRATIGRAPHIC CHARTS; PHOTOMICROGRAPHS; PHOTOGRAPHS

555

TILL GEOCHEMISTRY OF SOUTHWESTERN NOVA SCOTIA (SHEET 5) (1:100 000), BY R. R. STEA, 1983. 1 MAP(S) (TILL GEOCHEMICAL)

556

DEPOSITIONAL ENVIRONMENTS OF THE SYDNEY COAL BASIN, BY B. R. RUST, G. MASSON, 1983. 29 PAGES; 1 MAP(S) (STUDY AREA LOCATION); STRATIGRAPHIC COLUMNS

557

GEOLOGICAL MAPS OF THE HANTSPORT AREA (1:10 000), BY S. A. FERGUSON, 1983. 4 MAP(S) (GEOLOGICAL)

558

RECONNAISSANCE GEOLOGICAL AND GEOCHEMICAL INVESTIGATIONS IN THE COLLEGE GRANT-COPPER LAKE-GIANT LAKE AREAS OF ANTIGONISH AND GUYSBOROUGH COUNTIES, NOVA SCOTIA, BY L. V. MACCORMACK, 1967. 33 PAGES; 2 MAP(S) (SOIL SAMPLE LOCATION); STRATIGRAPHIC CHARTS

559

REPORT OF CONCENTRATION TEST ON AN ANTIMONY - GOLD ORE FROM WEST GORE, HANTS COUNTY, NOVA SCOTIA, BY E. L. CAMERON, 1950. 10 PAGES

560

AN UPDATE OF DEVELOPMENTS AT THE SALMON RIVER DEPOSIT, BY J. M. PATTERSON, 1978. 18 PAGES

561

SYDNEY COALFIELD PROJECTION, 1976 TO 2011 WITH SUPPLEMENTARY NOTE ON COAL PREPARATION, BY CAPE BRETON DEV CORP, 1976.

562

GEOLOGY AND ECONOMIC POSSIBILITIES OF THE MABOU COALFIELD, 1973. 11 PAGES; 1 MAP(S) (COAL SEAM LOCATION; DRILL HOLE LOCATION)

563

REPORT ON INTERCOLONIAL COAL COMPANY LIMITED, DRUMMOND COLLIERY, WESTVILLE, NOVA SCOTIA, BY INTERCOLONIAL COAL C L, 1951. 85 PAGES; MINE CROSS SECTIONS

564

LATE PALEOZOIC EVAPORITE DEPOSITS OF THE ATLANTIC PROVINCES AND ADJACENT OFFSHORE, BY R. D. HOWIE, 1976. 18 PAGES; 17 MAP(S) (STUDY AREA LOCATION; INDUSTRIAL MINERAL LOCATION; DRILL HOLE LOCATION; GEOLOGICAL; FACIES; PALEOGEOGRAPHIC; SUBSURFACE TOPOGRAPHIC; ISOPACHS); STRATIGRAPHIC COLUMNS; CROSS SECTIONS

565

MEMORANDUM ON THE MURPHY CAVE-IN, NORTHEAST MARGAREE, INVERNESS COUNTY, NOVA SCOTIA, BY G. R. CRANTON, 1959. 5 PAGES; 1 MAP(S) (GEOLOGICAL)

566

MEMORANDUM ON SUBSIDENCE PROBLEMS AT THE MINDAMAR MINE, STIRLING, RICHMOND COUNTY, NOVA SCOTIA, BY C. F. TOWNSEND, 1960. 1 PAGES; 1 MAP(S) (MINE LEVEL PLANS)

567

MEMORANDUM ON THE FILLING IN OF THE OPEN MINE SHAFT AT COXHEATH, INVERNESS COUNTY, NOVA SCOTIA, BY M. G. GOUDGE, 1970. 2 PAGES; 1 MAP(S) (MINE SURFACE PLANS); MINE CROSS SECTIONS

568

MEMORANDA ON SUBSIDENCE PROBLEMS IN THE WAVERLEY GOLD DISTRICT, HALIFAX COUNTY, NOVA SCOTIA, BY E. J. COLE, M. G. GOUDGE, R. SLATER, 1963. 12 PAGES; 3 MAP(S) (MINE SURFACE PLANS; STUDY AREA LOCATION)

569

INVESTIGATION TO RECOVER THE GOLD CONTAINED IN A SAMPLE SUBMITTED FROM FOREST HILL TAILING POND, NOVA SCOTIA, BY M. A. CRISTOVICI, G. W. LEIGH, 1983. CANMET DIVISION REPORT MRP/MSL 83-19 (IR). 82 PAGES; PHOTOMICROGRAPHS

570

PRELIMINARY GEOCHEMISTRY FOR THE COCHRANE HILL OPEN-PIT, BY P. K. SMITH, 1983. 14 PAGES; 3 MAP(S) (GEOLOGICAL; TOPOGRAPHIC; METALLIC MINERAL LOCATION; ROCK SAMPLE LOCATION); GEOCHEMICAL PROFILES; STRATIGRAPHIC COLUMNS

APPENDIX III

NOVA SCOTIA DEPARTMENT OF MINES AND ENERGY

PUBLICATIONS AND MAPS FOR SALE

NOVA SCOTIA DEPARTMENT OF MINES AND ENERGY

PUBLICATIONS AND MAPS FOR SALE

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Paper 77-1	Tectonics of Southern Nova Scotia, by J. D. Keppie, 34 pages (Reprinted 1980).	$3.00
Paper 77-3	Plate Tectonic Interpretation of Paleozoic World Maps (with Emphasis on Circum-Atlantic Orogens and Southern Nova Scotia), by J. D. Keppie, 45 pages (Reprinted 1982) (Microfiche $1.50)	$4.00
Paper 77-6	Sand and Gravel Resources of Pictou County, by J. H. Fowler and G. B. Dickie, 42 pages & map.	$4.00
Paper 77-7	Tungsten Mineralization in the Carbonate Rocks of the George River Group, Cape Breton Island, Nova Scotia, by A. K. Chatterjee, 26 pages.	$3.50
Paper 78-1	Geology of the Ecum Secum Area, Halifax and Guysborough Counties, Nova Scotia, by D. McBride, 12 pages.	$1.00
Paper 78-2	Age of Igneous Rocks along the Lennox Passage - St. Peter's Lineament, Southern Cape Breton Island, by J. D. Keppie and P. K. Smith, 10 pages.	$1.00
Paper 78-3	Geology of the Giant Lake Area, Southeastern Cape Breton Island, Nova Scotia, by P. K. Smith, 30 pages & map.	$2.00
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Paper 79-1	Petrology of the Late Precambrian Fourchu Group in the Louisbourg Area, Cape Breton Island, by J. D. Keppie, J. Dostal and J. B. Murphy, 18 pages.	$1.50
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Paper 79-3	Geology of the Meat Cove Zinc Deposit, Cape Breton Island, by A. K. Chatterjee, 27 pages.	$2.00
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Paper 80-1	Geology of the Cape North Area, Northern Cape Breton Island, Nova Scotia, by A. S. Macdonald and P. K. Smith, 60 pages & 2 maps. (Microfiche $2.00)	$5.00
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Paper 82-1	Geology and Geochemistry of Selected Granitoid Plutons of Cape Breton Island, by S. M. Barr, G. A. O'Reilly and A. M. O'Beirne, 176 pages, 44 figures, 13 tables. (Microfiche $2.00)	$8.00
Paper 82-2	Metasomatic-Hydrothermal Mineral Deposits of the New Ross-Mahone Bay Area, Nova Scotia, by G. A. O'Reilly, E. J. Farley and M. H. Charest, 96 pages. (Microfiche $1.50)	$5.00

REPORTS

Report 75-1	Report of Activities of the Mineral Resources and Geological Services Division, 1974, by Nova Scotia Department of Mines, 75 pages.	$1.00
Report 76-1	Drilling Logs of Government Core Drills, 1974, by I. MacDougall and D. W. Grimm, 73 pages.	$1.00
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Report 78-3	Superseded by Report 81-6	
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Report 82-4	Keyword Index to Open File Reports in NSDME Report 81-6, by N. A. Lyttle and J. Gillespie-Wood. (Microfiche only $1.00)	
Report 82-5	Keyword Index to GSC Documents on Nova Scotia to 1980. (Microfiche only $2.00)	
Report 82-6	Drilling Logs of Government Core Drills, 1981, compiled by Ian MacDougall and D. E. Polley, 1982, 60 pages. (Microfiche $1.50)	$3.50
Report 82-7	Uranium in Nova Scotia: A Background Summary for the Uranium Inquiry, Nova Scotia, 122 pages & 2 maps. (Microfiche $2.00)	$10.00
Report 83-1	Mines and Minerals Branch, Report of Activities, 1982, 404 pages. (Microfiche $3.50)	$10.00
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Report 83-3	Drilling Logs of Government Core Drills, 1982, compiled by Ian MacDougall and D. E. Polley, 1983, 38 pages. (Microfiche $2.00)	$3.50

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BULLETINS

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Bulletin 2 (Part 1)	Limestones and Dolomites of Nova Scotia, Part I- Cape Breton Island, by F. S. Shea and D. A. Murray, 1969, 300 pages & map.	$4.00

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Reprint 82-1	Observations on the Ichnology of the Meguma Group (?Cambro-Ordovician) of Nova Scotia, by R. K. Pickerill and J. Duncan Keppie, 1981, 9 pages. Reprinted from Maritime Sediments and Atlantic Geology, 17, 1981. (Microfiche $1.00)	$1.50
Reprint 82-2	A Rapid Method for the Determination of Gold and Silver in Sulfide Ores and Rocks, by R. R. Brooks, J. Holzbecher, D. E. Ryan, H. F. Zhang and A. K. Chatterjee, 1981, 4 pages. Reprinted from Atomic Spectroscopy, v.2, No. 5, 1981. (Microfiche only $1.00)	
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Reprint 82-4	The Minas Geofracture, by J. Duncan Keppie, 1982, 18 pages. Reprinted from GAC Special Paper 24. (Microfiche $1.00)	$2.00
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